VAMP 260

Power monitoring unit

Operation and configuration instructions

Technical description

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1. General

This part of the manual describes the functions of the power-monitoring unit VAMP 260 and includes the unit operation instructions. It also contains instructions for parameterization and configuration of the unit and instructions for changing settings.

The second part of the publication includes detailed protection function descriptions as well as application examples and technical data sheets.

The Mounting and Commissioning Instructions are published in a separate publication with the code VMMC.EN0xx.

1.1. Unit features

The VAMP 260 power-monitoring unit is a compact multi-function monitoring device with extensive measuring and calculation functions. The unit is based on the same hardware and software as the protection relays. The setting and programming possibilities are comprehensive and versatile. The VAMP 260 us ideal for utility, industrial, marine and off-shore power distribution management.

The unit measures currents, voltages and frequencies and calculates following values:

- Active, reactive and apparent power
- Active and reactive energy
- Harmonics and THD of currents and voltages
- Programmable average value calculations
- Four energy pulse outputs

Further, the unit includes 6 freely configurable digital or analogue channels and a disturbance recorder.

The unit communicates with other systems using common protocols, such as the ModBus RTU, ModBus TCP, Profibus DP, IEC 61850, IEC 60870-5-101 , IEC 60870-5-103 and it can be connected to a fibre-optic SPA bus.

1.2. User interface

The unit can be controlled in three ways:

- Locally with the push-buttons on the unit front panel
- Locally using a PC connected to the serial port on the front panel or on the rear panel of the unit (both cannot be used simultaneously)
- Via remote control over the remote control port on the unit rear panel.

1.3. Operating safety

The terminals on the rear panel of the unit may carry dangerous voltages, even if the auxiliary voltage is switched off. A live current transformer secondary circuit must not be opened. **Disconnecting a live circuit may cause dangerous voltages!** Any operational measures must be carried out according to national and local handling directives and instructions.

Carefully read through all operation instructions before any operational measures are carried out.

2. Local panel user interface

2.1. Unit front panel

The figure below shows the front panel of the unit and the location of the user interface elements used for local control.

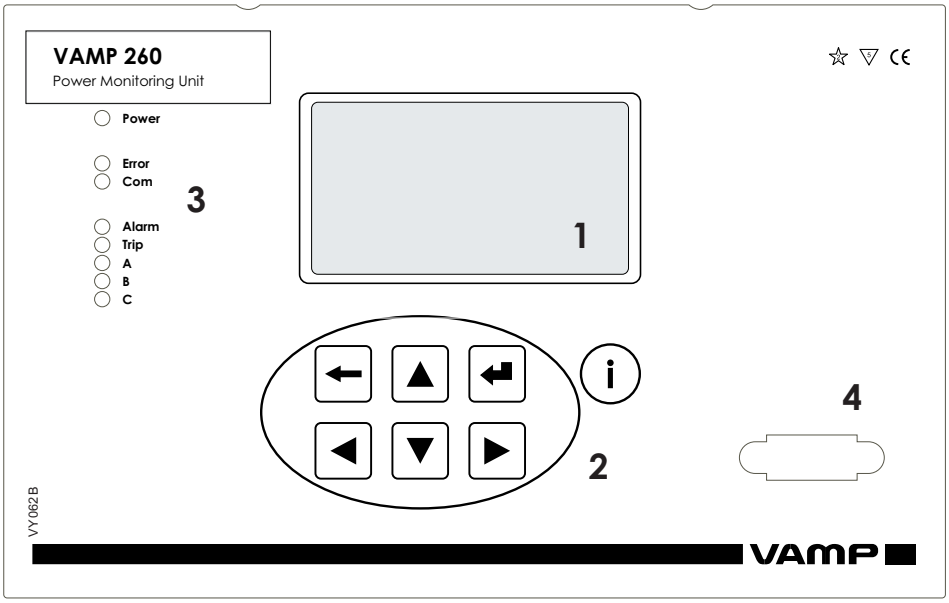

Figure 2.1-1. Unit front panel.

1. LCD dot matrix display
2. Key pad
3. LED indicators
4. RS 232 serial communication port for PC

2.1.1. Display

The VAMP 260 is provided with a backlit LCD dot matrix display. The display is divided into sections as shown in the next figure.

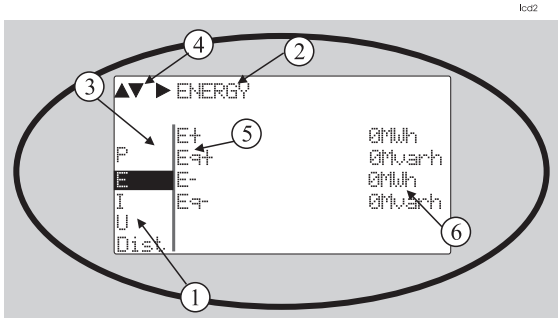

Figure 2.1.1-1 Sections of the LCD dot matrix display

1. Main menu column
2. The heading of the active menu
3. The cursor of the main menu
4. Possible navigating directions (push buttons)
5. Measured/setting parameter
6. Measured/set value

2.1.2. Menu navigation and pointers

1. Use the arrow keys UP and DOWN to move up and down in the main menu, that is, on the left-hand side of the display. The active main menu option is indicated with a cursor. The options in the main menu items are abbreviations, e.g. Evnt = events.
2. After any selection, the arrow symbols in the upper left corner of the display show the possible navigating directions (applicable navigation keys) in the menu.
3. The name of the active submenu and a possible ANSI code of the selected function are shown in the upper part of the display, e.g. CURRENTS.
4. Further, each display holds the measured values and units of one or more quantities or parameters, e.g. ILmax 300A.

2.1.3. Key pad

You can navigate in the menu and set required parameter values using the key pad and the guidance given in the display. The key pad is composed of four arrow keys, one cancel key, one enter key and one info key.

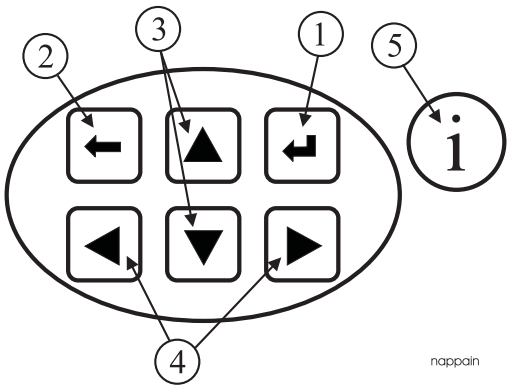

Figure 2.1.3-1. The keys on the key pad.

1. Enter and confirmation key (ENTER)
2. Cancel key (CANCEL)
3. Up/Down [Increase/Decrease] arrow keys (UP/DOWN)
4. Selection of submenus [selection of digit in numerical value] (LEFT/RIGHT)
5. Additional information key (INFO)

NOTE! The term, which is used for the buttons in this manual, is inside the brackets.

2.1.4. Operation indicators

The unit is provided with eight LED indicators on the unit front panel:

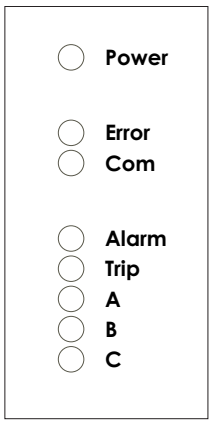

Figure 2.1.4-1. Operation indicators of the unit.

Relay operation indicators

LED indicator	Explanation	Measure/ Remarks
Power LED lit	The auxiliary power has been switched on	Normal operation state
Error LED lit	An internal unit fault has been detected	The unit attempts to reboot. If the error LED remains lit, call for maintenance.
Com LED lit or flashing	The serial bus is in use and transferring information	Normal operation state
Alarm LED lit	Application related status indicators.	
Trip LED lit	Application related status indicators.	
A-C LED lit	Application related status indicators.	

Resetting latched indicators and output relays

All the indicators and output relays can be given a latching function in the configuration.

There are several ways to reset latched indicators and relays:

- From the alarm list, move back to the initial display by pushing the CANCEL key for approx. 3 s. Then reset the latched indicators and output relays by pushing the ENTER key.
- Acknowledge each event in the alarm list one by one by pushing the ENTER key equivalent times. Then, in the initial display, reset the latched indicators and output relays by pushing the ENTER key.

The latched indicators and relays can also be reset via a remote communication bus or via a digital input configured for that purpose.

2.1.5. Adjusting display contrast

The readability of the LCD varies with the brightness and the temperature of the environment. The contrast of the display can be adjusted via the PC user interface, see chapter 3 on page 30.

2.2. Local panel operations

The local panel can be used to read measured values, to set parameters and to configure unit functions. Some parameters, however, can only be set by means of a PC connected to one of the local communication ports. Further some parameters are factory set.

2.2.1. Navigating in menus

All the menu functions are based on the main menu/submenu structure:

1. Use the arrow keys UP and DOWN to move up and down in the main menu.
2. To move to a submenu, repeatedly push the RIGHT key until the required submenu is shown. Correspondingly, push the LEFT key to return to the main menu.
3. Push the ENTER key to confirm the selected submenu. If there are more than six items in the selected submenu, a black line appears to the right side of the. It is then possible to scroll down in the submenu.
4. Push the CANCEL key to cancel a selection.
5. Pushing the UP or DOWN key in any position of a sub-menu, when it is not selected, brings you directly one step up or down in the main menu.

The active main menu selection is indicated with black background color. The possible navigating directions in the menu are shown in the upper-left corner by means of black triangular symbols.

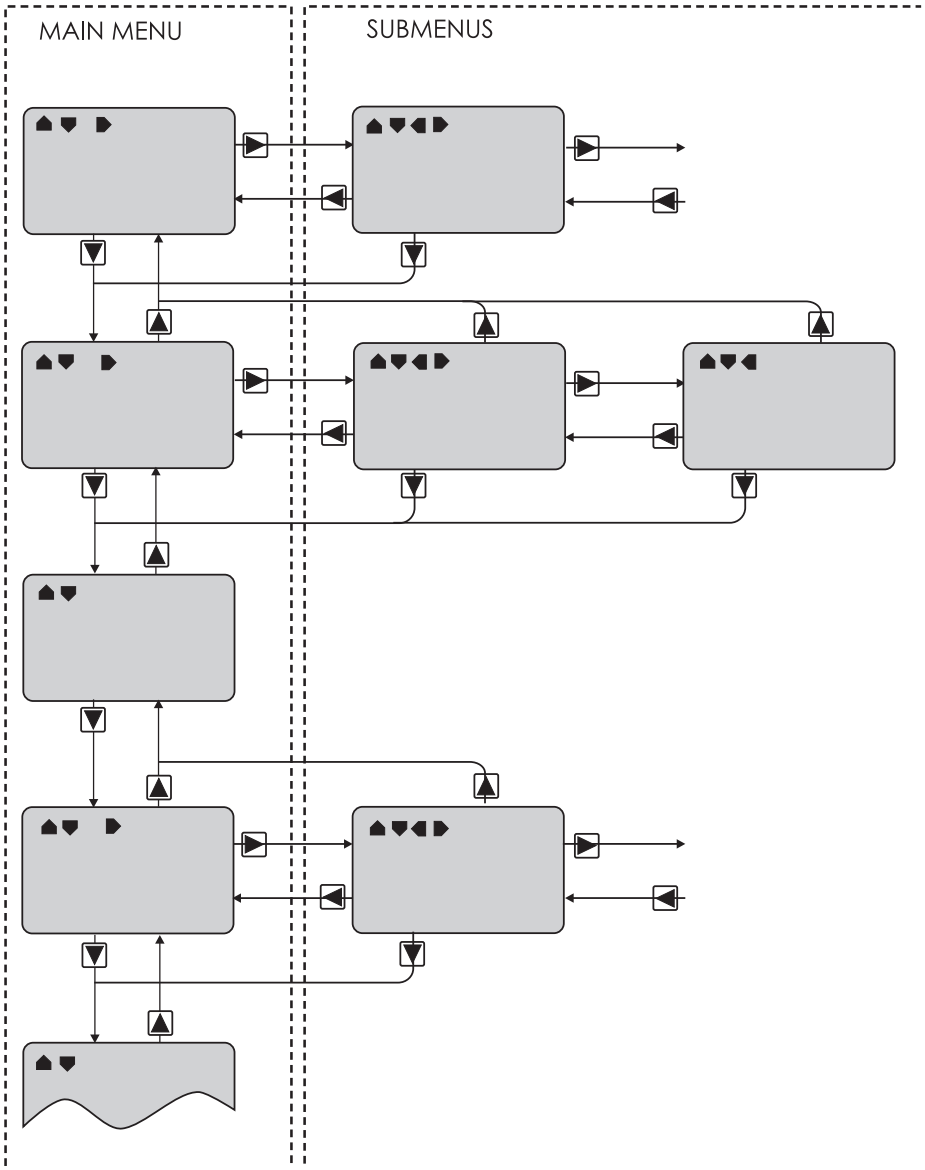

Figure 2.2.1-1. Principles of the menu structure and navigation in the menus

6. Push the INFO key to obtain additional information about any menu item.
7. Push the CANCEL key to revert to the normal display.

Main menu

The general menu structure is shown in Figure 2.2.1-1. The menu is dependent on the user's configuration and the options according the order code. For example only the enabled protection stages will appear in the menu.

A list of the local main menu

Main menu	Number of menus	Description	Note
	1	Interactive mimic display	1
	5	Double size measurements defined by the user	1
	1	Title screen with device name, time and firmware version.	
P	14	Power measurements	
E	5	Energy measurements	
I	14	Current measurements	
U	19	Voltage measurements	
Dema	15	Demand values	
Umax	8	Time stamped min & max of voltages	
Imax	7	Time stamped min & max of currents	
Pmax	5	Time stamped min & max of power and frequency	
Mont	19	Maximum values of the last 31 days and the last twelve months	
Evnt	2	Events	
DR	3	Disturbance recorder	2
Runh	2	Running hour counter. Active time of a selected digital input and time stamps of the latest start and stop.	
TIMR	6	Day and week timers	
DI	5	Digital inputs including virtual inputs	
DO	4	Digital outputs (relays) and output matrix	
ExtAI	3	External analogue inputs	3
ExtAO	3	Externa analogue outputs	3
ExDI	3	External digital inputs	3
ExDO	3	External digital outputs	3
AO	5	Analogue outputs	
Alrm	5	Alarm stages	
Prg1	3	1st programmable stage	4
Prg2	3	2nd programmable stage	4
Prg3	3	3rd programmable stage	4
Prg4	3	4th programmable stage	4
Prg5	3	5th programmable stage	4
Prg6	3	6th programmable stage	4
Prg7	3	7th programmable stage	4
Prg8	3	8th programmable stage	4
OBJ	11	Object definitions	5
Lgic	2	Status and counters of user's logic	1
CONF	9+1	Device setup, scaling etc.	6
Bus	12	Serial port and protocol configuration	7
Diag	8	Device selfdiagnosis	

Notes

1 Configuration is done with VAMPSET
2 Recording files are read with VAMPSET
3 The menu is visible only if protocol "ExternalIO" is selected for one of the serial ports. Serial ports are configured in menu "Bus".
4 The menu is visible only if the stage is enabled.
5 Objects are circuit breakers, disconnectors etc.. Their position or status can be displayed and controlled in the interactive mimic display.
6 There is one extra menu, which is visible only if the access level "operator" or "configurator" has been opened with the corresponding password.
7 Detailed protocol configuration is done with VAMPSET.

2.2.2. Operating levels

The unit has three operating levels: **User level**, **Operator level** and **Configurator level**. The purpose of the access levels is to prevent accidental change of unit configurations, parameters or settings.

USER level

Use:	Possible to read e.g. parameter values, measurements and events
Opening:	Level permanently open
Closing:	Closing not possible

OPERATOR level

Use:	Possible to control objects and to change e.g. the settings of the protection stages
Opening:	Default password is 1
Setting state:	Push ENTER
Closing:	The level is automatically closed after 10 minutes idle time. Giving the password 9999 can also close the level.

CONFIGURATOR level

Use:	The configurator level is needed during the commissioning of the unit. E.g. the scaling of the voltage and current transformers can be set.
Opening:	Default password is 2
Setting state:	Push ENTER
Closing:	The level is automatically closed after 10 minutes idle time. Giving the password 9999 can also close the level.

Opening access

1. Push the INFO key and the ENTER key on the front panel.

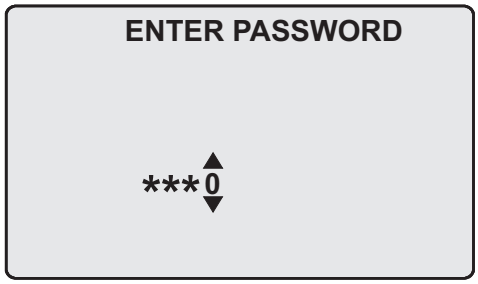

Figure 2.2.2-1. Opening an operating level

2. Enter the password needed for the desired level: The password may contain four digits. The digits are supplied one by one by first moving to the position of the digit using the RIGHT key and then setting the desired digit value using the UP key.
3. Push ENTER.

Password handling

The passwords can only be changed using VAMPSET software connected to the local RS-232 port on the relay.

It is possible to restore the password(s) in case the password is lost or forgotten. In order to restore the password(s), a relay program is needed. The serial port settings are 38400 bps, 8 data bits, no parity and one stop bit. The bit rate is configurable via the front panel.

Command	Description
get pwd_break	Get the break code (Example: 6569403)
get serno	Get the serial number of the relay (Example: 12345)

Send both the numbers to vampsupport@vamp.fi and ask for a password break. A device specific break code is sent back to you. That code will be valid for the next two weeks.

Command	Description
set pwd_break=4435876	Restore the factory default passwords (“4435876” is just an example. The actual code should be asked from VAMP Ltd.)

Now the passwords are restored to the default values (See chapter 2.2.2).

2.3. Operating measures

2.3.1. Measured data

The measured values can be read from the P, E, I and U menus and their submenus. Furthermore, any measurement value in the following table can be displayed on the main view next to the single line diagram. Up to six measurements can be shown.

Value	Menu/Submenu	Description
P	P/POWER	Active power [kW]
Q	P/POWER	Reactive power [kvar]
S	P/POWER	Apparent power [kVA]
φ	P/POWER	Active power angle [°]
P.F.	P/POWER	Power factor
f	P/POWER	Frequency [Hz]
Prms	P/RMS POWER	Active power [kW] RMS value
Qrms	P/RMS POWER	Reactive power [kvar] RMS value
Srms	P/RMS POWER	Apparent power [kVA] RMS value
Pda	P/POWER DEMAND	Active power [kW] demand
Qda	P/POWER DEMAND	Reactive power [kvar] demand
Sda	P/POWER DEMAND	Apparent power [kVA] demand
Pfda	P/POWER DEMAND	Power factor demand
fda	P/POWER DEMAND	Frequency [Hz] demand
Prms	P/RMS POWER DEMAND	Active power [kW] demand RMS value
Qrms	P/RMS POWER DEMAND	Reactive power [kvar] demand RMS value
Srms	P/RMS POWER DEMAND	Apparent power [kVA] demand RMS value
PL1	P/POWER/PHASE 1	Active power of phase 1 [kW]
PL2	P/POWER/PHASE 1	Active power of phase 2 [kW]
PL3	P/POWER/PHASE 1	Active power of phase 3 [kW]
QL1	P/POWER/PHASE 1	Reactive power of phase 1 [kvar]
QL2	P/POWER/PHASE 1	Reactive power of phase 2 [kvar]
QL3	P/POWER/PHASE 1	Reactive power of phase 3 [kvar]
SL1	P/POWER/PHASE 2	Apparent power of phase 1 [kVA]
SL2	P/POWER/PHASE 2	Apparent power of phase 2 [kVA]
SL3	P/POWER/PHASE 2	Apparent power of phase 3 [kVA]
PF_L1	P/POWER/PHASE 2	Power factor of phase 1
PF_L2	P/POWER/PHASE 2	Power factor of phase 2
PF_L3	P/POWER/PHASE 2	Power factor of phase 3
CosFii	P/COS & TAN	Cosine phi
TanFii	P/COS & TAN	Tangent phi
cosL1	P/COS & TAN	Cosine phi of phase L1
cosL2	P/COS & TAN	Cosine phi of phase L2
cosL3	P/COS & TAN	Cosine phi of phase L3

Value	Menu/Submenu	Description
Iseq	P/PHASE SEQUENCIES	Actual current phase sequency [OK; Reverse; ??]
Useq	P/PHASE SEQUENCIES	Actual voltage phase sequency [OK; Reverse; ??]
fAdop	P/PHASE SEQUENCIES	Adapted network frequency [Hz]
E+	E/ENERGY	Exported energy [MWh]
Eq+	E/ENERGY	Exported reactive energy [Mvar]
E-	E/ENERGY	Imported energy [MWh]
Eq-	E/ENERGY	Imported reactive energy [Mvar]
RunH	E/ENERGY	Engine running hours [h]
E+.nn	E/DECIMAL COUNT	Decimals of exported energy
Eq.nn	E/DECIMAL COUNT	Decimals of reactive energy
E-.nn	E/DECIMAL COUNT	Decimals of imported energy
Ewrap	E/DECIMAL COUNT	Maximum energy counter value
E+	E/E-PULSE SIZES	Pulse size of exported energy [kWh]
Eq+	E/E-PULSE SIZES	Pulse size of exported reactive energy [kvar]
E-	E/E-PULSE SIZES	Pulse size of imported energy [kWh]
Eq-	E/E-PULSE SIZES	Pulse duration of imported reactive energy [ms]
E+	E/E-PULSE DURATION	Pulse duration of exported energy [ms]
Eq+	E/E-PULSE DURATION	Pulse duration of exported reactive energy [ms]
E-	E/E-PULSE DURATION	Pulse duration of imported energy [ms]
Eq-	E/E-PULSE DURATION	Pulse duration of imported reactive energy [ms]
E+	E/ENERGY DOSE	Exported energy trip [MWh]
Timer	E/ENERGY DOSE	Remaining Etrip time [min]
Time	E/ENERGY DOSE	Etrip counting time [min]
P	E/ENERGY DOSE	Active power [kW]
IL1	I/PHASE CURRENTS	Phase current IL1 [A]
IL2	I/PHASE CURRENTS	Phase current IL2 [A]
IL3	I/PHASE CURRENTS	Phase current IL3 [A]
IL1da	I/PHASE CURRENTS	15 min average for IL1 [A]
IL2da	I/PHASE CURRENTS	15 min average for IL2 [A]
IL3da	I/PHASE CURRENTS	15 min average for IL3 [A]
ILRMS	I/RMS CURRENTS	Phase current RMS value
IL1RMS	I/RMS CURRENTS	IL1 current RMS value
IL2RMS	I/RMS CURRENTS	IL2 current RMS value
IL3RMS	I/RMS CURRENTS	IL3 current RMS value
IoCalc	I/SYMMETRIC CURRENTS	Calculated Io [A]
I1	I/SYMMETRIC CURRENTS	Positive sequence current [A]
I2	I/SYMMETRIC CURRENTS	Negative sequence current [A]

Value	Menu/Submenu	Description
I2/I1	I/SYMMETRIC CURRENTS	Negative sequence current related to positive sequence current (for unbalance protection) [%]
THDIL	I/HARM. DISTORTION	Total harmonic distortion of the mean value of phase currents [%]
THDIL1	I/HARM. DISTORTION	Total harmonic distortion of phase current IL1 [%]
THDIL2	I/HARM. DISTORTION	Total harmonic distortion of phase current IL2 [%]
THDIL3	I/HARM. DISTORTION	Total harmonic distortion of phase current IL3 [%]
Diagram	I/HARMONICS of IL1	Harmonics of phase current IL1 [%] (see Figure 2.3.1-1)
Diagram	I/HARMONICS of IL2	Harmonics of phase current IL2 [%] (see Figure 2.3.1-1)
Diagram	I/HARMONICS of IL3	Harmonics of phase current IL3 [%] (see Figure 2.3.1-1)
Uline	U/LINE VOLTAGES	Average value for the three line voltages [V]
U12	U/LINE VOLTAGES	Phase-to-phase voltage U12 [V]
U23	U/LINE VOLTAGES	Phase-to-phase voltage U23 [V]
U31	U/LINE VOLTAGES	Phase-to-phase voltage U31 [V]
UL	U/PHASE VOLTAGES	Average for the three phase voltages [V]
UL1	U/PHASE VOLTAGES	Phase-to-earth voltage UL1 [V]
UL2	U/PHASE VOLTAGES	Phase-to-earth voltage UL2 [V]
UL3	U/PHASE VOLTAGES	Phase-to-earth voltage UL3 [V]
URMS	U/RMS VOLTAGES	Average voltage RMS value [V]
UaRMS	U/RMS VOLTAGES	Voltage input a RMS value [V]
UbRMS	U/RMS VOLTAGES	Voltage input b RMS value [V]
UcRMS	U/RMS VOLTAGES	Voltage input c RMS value [V]
U1	U/SYMMETRIC VOLTAGES	Positive sequence voltage [%]
U2	U/SYMMETRIC VOLTAGES	Negative sequence voltage [%]
U2/U1	U/SYMMETRIC VOLTAGES	Negative sequence voltage related to positive sequence voltage [%]
THDU	U/HARM. DISTORTION	Total harmonic distortion of the mean value of voltages [%]
THDUa	U/HARM. DISTORTION	Total harmonic distortion of the voltage input a [%]
THDUb	U/HARM. DISTORTION	Total harmonic distortion of the voltage input b [%]
THDUc	U/HARM. DISTORTION	Total harmonic distortion of the voltage input c [%]
Diagram	U/HARMONICS of input Ua	Harmonics of voltage input Ua [%] (see Figure 2.3.1-1)
Diagram	U/HARMONICS of input Ub	Harmonics of voltage input Ub [%] (see Figure 2.3.1-1)

Value	Menu/Submenu	Description
Diagram	U/HARMONICS of input Uc	Harmonics of voltage input Uc [%] (see Figure 2.3.1-1)
Count	U/VOLT. INTERRUPTS	Voltage interrupt counter
Prev	U/VOLT. INTERRUPTS	Previous interruption
Total	U/VOLT. INTERRUPTS	Total duration of voltage interruptions [days, hours]
Prev	U/VOLT. INTERRUPTS	Duration of previous interruption
Status	U/VOLT. INTERRUPTS	Voltage status [LOW; NORMAL]

harm

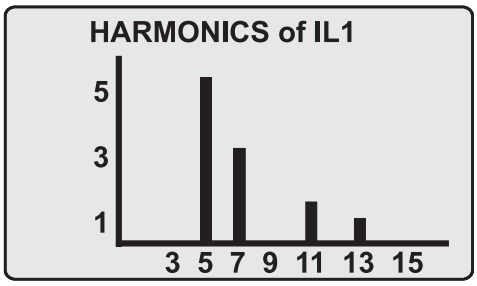

Figure 2.3.1-1. Example of harmonics bar display

2.3.2. Reading event register

The event register can be read from the Evnt option of the main menu:

1. Push the RIGHT key once
2. The EVENT LIST appears. The display contains a list of all events that have been configured to be contained in the event register.

event_list_VAMP260

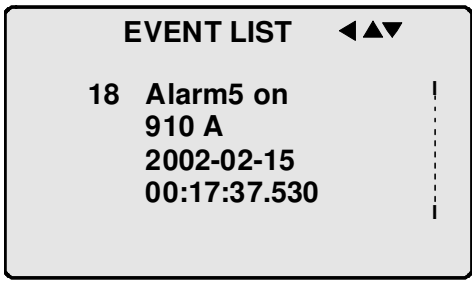

Figure 2.3.2-1 Event register, example.

3. Scroll through the event list with the UP and DOWN keys.
4. Exit the event list by pushing the LEFT key.

2.3.3. Forced control (Force)

In some menus it is possible to switch a signal on and off by using a force function. This feature can be used, for instance, for testing a certain function. The force function can be activated as follows:

1. Open Access level CONFIGURATION
2. Move to the setting state of the desired function, for example DO (see chapter 2.4, on page 20).
3. Select the Force function (the black cursor is in line with the Force text).

VAMP 260 force

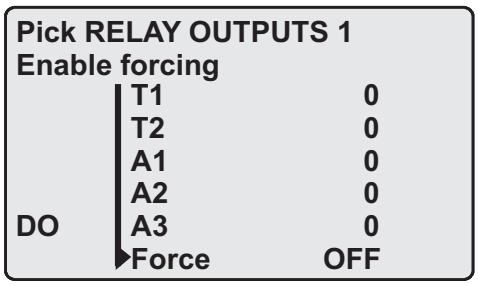

Figure 2.3.3-1 Selection of the Force function.

4. Push the ENTER key.
5. Push the UP or DOWN key to change the "OFF" text to "ON", i.e., to activate the Force function.
6. Push the ENTER key to return to the selection list. Choose the signal to be controlled by force with the UP and DOWN keys, for instance the T1 signal.
7. Push the ENTER key to confirm the selection. Signal T1 can be controlled by force.
8. Push the UP or DOWN key to change the selection from "0" (not alert) to "1" (alert) or vice versa.
9. Push the ENTER key to execute the forced control operation of the selected function, e.g., making the output relay of T1 to pick up.
10. Repeat steps 8 and 9 to alternate between the on and off state of the function.
11. Repeat steps 1...4 to exit the Forced control function.
12. Push the CANCEL key to return to the main menu.

NOTE! All the interlockings and blockings are bypassed when the force control is used.

2.4. Configuration and parameter setting

The minimum procedure to configure a unit is

1. Open the access level "Configurator". The default password for configurator access level is 2.
2. Set the rated values in menu [CONF] including at least current transformers and voltage transformers ratings. Also the date and time settings are in this same main menu.
3. Configure the needed digital outputs in main menu [DO].
4. Configure the needed digital inputs in main menu [DI].
5. Configure the needed analog outputs in main menu [AO].
6. Choose and configure the alarm functions and configure the interlockings in main menu [Alrm].
7. Choose and configure the communication buses in main menu [Bus].

Some of the parameters can only be changed via the RS-232 serial port using the VAMPSET software. Such parameters, (for example passwords, blockings and mimic configuration) are normally set only during commissioning.

Some of the parameters require the restarting of the unit. This restarting is done automatically when necessary. If a parameter change requires restarting, the display will show as Figure 2.4-1.

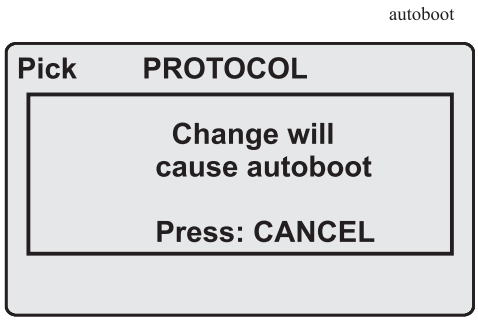

Figure 2.4-1 Example of auto-reset display

Press CANCEL to return to the setting view. If a parameter must be changed, press the ENTER key again. The parameter can now be set. When the parameter change is confirmed with the ENTER key, a [RESTART]- text appears to the top-right corner of the display. This means that auto-resetting is pending. If no key is pressed, the auto-reset will be executed within few seconds.

2.4.1. Parameter setting

1. Move to the setting state of the desired menu, e.g. CONF/SCALING, by pushing the ENTER key. The Pick text appears in the upper left part of the display.
2. Supply the password associated with the configuration level (default value = 0002).
3. Scroll through the parameters with the UP and DOWN keys. If a certain parameter can be set, the cursor to the left of the value takes the form of a black filled triangle. If the parameter cannot be set the cursor takes the form of a non-filled triangle.
4. Select the desired parameter, e.g. Inom, with the ENTER key.
5. Use the UP and DOWN keys to change a parameter value. If the value contains more than one digit, use the LEFT and RIGHT keys to step from digit to digit, and the UP and DOWN keys to change the digits.
6. Push the ENTER key to accept the new value.
7. If you want to leave the parameter value unchanged, then exit the edit state by pushing the CANCEL key.

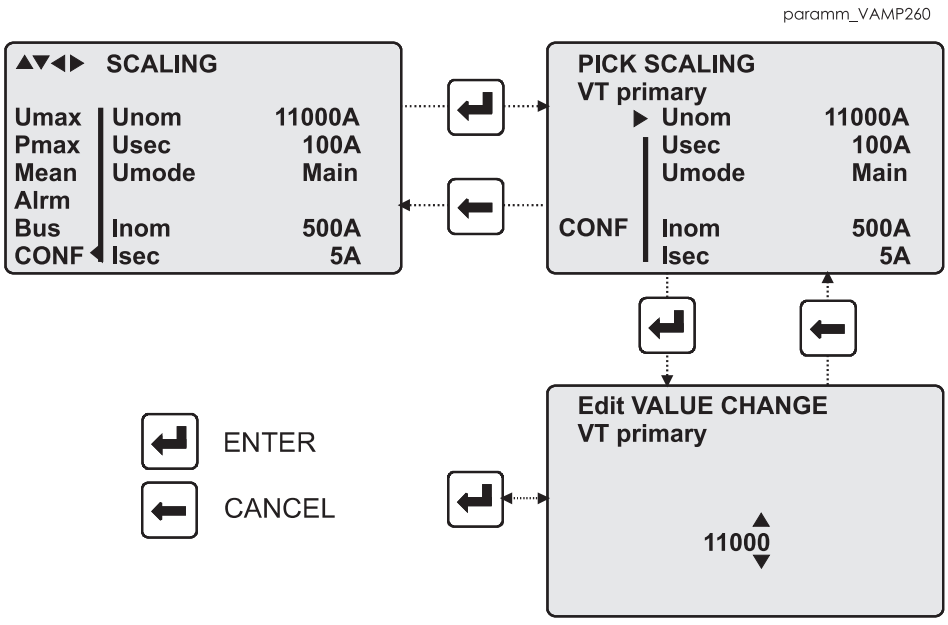

Figure 2.4-2 Changing parameters.

2.4.2. Setting range limits

If the given parameter setting values are out-of-range values, a fault message will be shown when the setting is confirmed with the ENTER key. Adjust the setting to be within the allowed range.

illegal

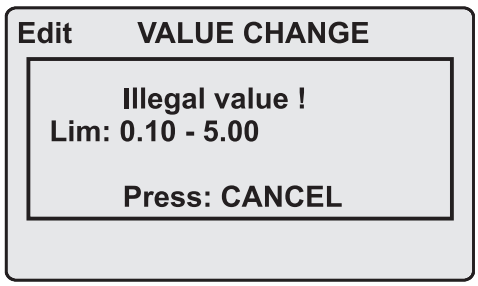

Figure 2.4.2-1 Example of a fault message

The allowed setting range is shown in the display in the setting mode. To view the range, push the INFO key. Push the CANCEL key to return to the setting mode.

infoset_I

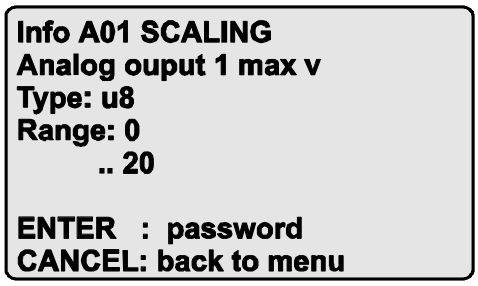

Figure 2.4.2-2. Allowed setting ranges show in the display

2.4.3. Disturbance recorder menu DR

Via the submenus of the disturbance recorder menu the following functions and features can be read and set:

DISTURBANCE RECORDER

- Recording mode (Mode)
- Sample rate (Rate)
- Recording time (Time)
- Pre trig time (PreTrig)
- Manual trigger (MnlTrig)
- Count of ready records (ReadyRe)

REC. COUPLING

- Add a link to the recorder (AddLink)
- Clear all links (ClrLnks)

Available links:

- DO, DI
- Uline, Uphase
- IL
- U2/U1, U2, U1
- I2/In, I2/I1, I2, I1, IoCalc
- CosFii
- PF, S, Q, P
- f
- Uo, UL3, UL2, UL1
- U31, U23, U12
- IL3, IL2, IL1
- Prms, Qrms, Srms
- Tanfii
- THDIL1, THDIL2, THDIL3
- THDUa, THDUb, THDUc
- IL3RMS, IL2RMS, IL1RMS
- ILmin, ILmax, ULLmin, ULLmax, ULNmin, ULNmax

2.4.4. Configuring digital inputs DI

Via the submenus of the digital inputs menu the following functions can be read and set:

- Status of digital inputs (DIGITAL INPUTS)
- Operation counters (DI COUNTERS)
- Operation delay (DELAYs for DigIn)
- Polarity of the input signal (INPUT POLARITY), either normally open (NO) or normally closed (NC) circuit
- Selection to event register EVENT MASK1 and EVENT MASK2

2.4.5. Configuring digital outputs DO

The following functions can be read and set via the submenus of the digital outputs menu:

- The status of the output relays (RELAY OUTPUTS1 and 2)
- The forcing of the output relays (RELAY OUTPUTS1 and 2) (only if Force = ON):
    - Forced control (0 or 1) of the Trip relays
    - Forced control (0 or 1) of the Alarm relays
    - Forced control (0 or 1) of the IF relay
- The configuration of the output signals to the output relays. The configuration of the operation indicators (LED) Alarm and Trip and application specific alarm leds A, B and C (that is, the output relay matrix).

NOTE! The amount of Trip and Alarm relays depends on the relay type and optional hardware.

2.4.6. Configuring analogue outputs AO

Via the submenus of the analogue output menu the following functions and features can be read and set:

ANALOG OUTPUTS

- Value of AO1 (AO1)
- Value of AO2 (AO2)
- Value of AO3 (AO3)
- Value of AO4 (AO4)
- Forced control of analogue outputs (Force)

ANALOG OUTPUT 1-4

- Value linked to the analogue output (Lnk1-4)
- (See list available links)
- Scaled minimum of linked value (Min)
- Scaled maximum of linked value (Max)
- Scaled minimum of analogue output (AOmin)
- Scaled maximum of analogue output (AOmax)
- Value of analogue output (AO1-4)

Available links:

- P, Q, S
- f
- PF
- Cosφ
- IL1, IL2, IL3
- U12, U23, U31
- UL1, UL2, UL3
- IL
- Uline, Uphase
- SagMin, SwellMax
- PrgVal
- Uo
- IoCalc

2.4.7. Setting alarm stage parameters

The settings of the selected alarm stages can be read and set separately in the Alrm submenus. There are 8 different alarm stages, which can be separately enabled or disabled. In any of the stages any one of the available variables can be chosen.

Available link variables

- P, Q, S
- f
- CosFii, TanFii
- IL1, IL2, IL3, IL, IoCalc, I1, I2, I2/I1, I2/In, ILmin, ILmax
- THDIL1, THDIL2, THDIL3
- U12, U23, U31, Uline, UL1, UL2, UL3, Uphase, U1, U2, U2/U1, ULLmin, ULLmax, ULNmin, ULNmax
- THDUa, THDUb, THDUc
- Prms, Qrms, Srms
- IL1rms, IL2rms, IL3rms
- Uo

2.4.8. Configuration menu CONF

The following functions and features can be read and set via the submenus of the configuration menu:

DEVICE SETUP

- Bit rate for the command line interface in ports X4 and the front panel. The front panel is always using this setting. If SPABUS is selected for the rear panel local port X4, the bit rate is according SPABUS settings.
- Access level [Acc]
- PC access level [PCAcc]

LANGUAGE

- List of available languages in the relay

CURRENT SCALING

- Rated phase CT primary current (Inom)
- Rated phase CT secondary current (Isec)

VOLTAGE SCALING

- Rated VT primary voltage (Un)
- Rated VT secondary voltage (Usec)
- Voltage measuring mode (Umode)

UNITS FOR MIMIC DISPLAY

- Unit for voltages (V). The choices are V (volt) or kV (kilovolt).

- Scaling for active, reactive and apparent power [Power]. The choices are k for kW, kvar and kVA or M for MW, Mvar and MVA.

FUNDAMENTAL/RMS

- Energy calculation mode. The choices are Fundam and RMS.
- Display fundamental measurements. The choices are On and Off.

Display RMS measurements. The choices are On and Off.

DEVICE INFO

- Relay type (Type VAMP 260)
- Serial number (SerN)
- Software version (PrgVer)
- Bootcode version (BootVer)

DATE/TIME SETUP

- Day, month and year (Date)
- Time of day (Time)
- Date format (Style). The choices are "yyyy-mm-dd", "dd.nn.yyyy" and "mm/dd/yyyy".

CLOCK SYNC

- Minute sync pulse DI (SyncDI)
- Time zone for NPT (TZone)
- NTP daylight saving time (DST)
- Sync source (SySrc)
- Sync message counter (MsgCnt)
- Latest time deviation (Dev)

CLOCK SYNC 2

- Sync correction (SyOS)
- Auto adjust interval (AAIntv)
- Average drift (AvDrft)
- Filtered sync deviation (FilDev)

2.4.9. Protocol menu Bus

There are three communication ports in the rear panel. In addition there is a connector in the front panel overruling the local port in the rear panel.

REMOTE PORT X5

- Communication protocol for remote port X5 [Protocol].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].

- Information of bit rate/data bits/parity/stop bits.
  This value is not directly editable. Editing is done in the appropriate protocol setting menus.

The counters are useful when testing the communication.

LOCAL PORT X4 (pins 2, 3 and 5)

This port is disabled, if a cable is connected to the front panel connector.

- Communication protocol for the local port X4 [Protocol]. For VAMPSET use "None" or "SPABUS".
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits.
  This value is not directly editable. Editing is done in the appropriate protocol setting menus. For VAMPSET and protocol "None" the setting is done in menu CONF/DEVICE SETUP.

PC (LOCAL/SPA BUS)

This is a second menu for local port X4. The VAMPSET communication status is showed.

- Bytes/size of the transmitter buffer [Tx].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].
- Same information as in the previous menu.

EXTENSION PORT X4 (pins 7, 8 and 5)

- Communication protocol for extension port X4 [Protocol].
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors].
- Communication time-out error counter [Tout].
- Information of bit rate/data bits/parity/stop bits.
  This value is not directly editable. Editing is done in the appropriate protocol setting menus.

TCP/IP

These TCP/IP parameters are used by the optional ethernet interface. For changing the nnn.nnn.nnn.nnn style parameter values, VAMPSET is recommended.

- Communication protocol for TCP/IP
- Protocol port for IP [Port]. Default is 502.
- Netmask [NetMsk].
- Gateway [Gatew].
- Network time protocol (NTP) server [NTPSvr].
- MAC address of the Ethernet interface [MAC].
- Vampset port for IP [VS Port]. Default is 23.
- Message counter [Msg#]. This can be used to verify that the device is receiving messages.
- Communication error counter [Errors]
- Communication time-out error counter [Tout].

MODBUS

- Modbus addres for this slave device [Addr]. This address has to be unique within the system.
- Modbus bit rate [bit/s]. Default is "9600".
- Parity [Parity]. Default is "Even".

For details see the technical description part of the manual.

EXTERNAL I/O protocol

This is a Modbus master protocol to communicate with the extension I/O modules connected to the extension port. Only one instance of this protocol is possible.

- Bit rate [bit/s]. Default is "9600".
- Parity [Parity]. Default is "Even".

For details see the technical description part of the manual.

SPA BUS

Several instances of this protocol are possible.

- SPABUS addres for this device [Addr]. This address has to be unique within the system.
- Bit rate [bit/s]. Default is "9600".
- Event numbering style [Emode]. Default is "Channel".

For details see the technical description part of the manual.

IEC 60870-5-103

Only one instance of this protocol is possible.

- Address for this device [Addr]. This address has to be unique within the system.
- Bit rate [bit/s]. Default is "9600".
- Minimum measurement response interval [MeasInt].
- ASDU6 response time mode [SyncRe].

For details see the technical description part of the manual.

IEC 103 DISTURBANCE RECORDINGS

For details see the technical description part of the manual.

PROFIBUS

Only one instance of this protocol is possible.

- Mode for Profibus. Choices are Continous and Request [Mode]
- Bit rate [bit/s]. Use 2400 bps. This parameter is the bit rate between the main CPU and the Profibus ASIC. The actual Profibus bit rate is automatically set by the Profibus master and can be up to 12 Mbit/s.
- Event numbering style [Emode].
- Size of the Profibus Tx buffer [InBuf].
- Size of the Profibus Rx buffer [OutBuf].
  When configuring the Profibus master system, the length of these buffers are needed. The size of the both buffers is set indirectly when configuring the data items for Profibus.
- Address for this slave device [Addr]. This address has to be unique within the system.
- Profibus converter type [Conv]. If the shown type is a dash "", either Profibus protocol has not been selected or the device has not restarted after protocol change or there is a communication problem between the main CPU and the Profibus ASIC.

For details see the technical description part of the manual.

DNP3

Only one instance of this protocol is possible.

- Bit rate [bit/s]. Default is "9600".
- [Parity].
- Addres for this device [SlvAddr]. This address has to be unique within the system.
- Master's addres [MstrAddr].

For further details see the technical description part of the manual.

IEC 60870-5-101

- Bit rate [bit/s]. Default is “9600”.
- [Parity].
- Link layer address for this device [LLAddr].
- ASDU address [ALAddr].

For further details see the technical description part of the manual.

3. VAMPSET PC software

The PC user interface can be used for:

- On-site parameterization of the unit
- Loading unit software from a computer
- Reading measured values, registered values and events to a computer.
- Continuous monitoring of all values and events.

Two RS 232 serial ports are available for connecting a local PC with VAMPSET to the unit; one on the front panel and one on the rear panel of the unit. These two serial ports are connected in parallel. However, if the connection cables are connected to both ports, only the port on the front panel will be active. To connect a PC to a serial port, use a connection cable of type VX 003-3.

The VAMPSET program can also use TCP/IP LAN connection. Optional hardware is required.

There is a free of charge PC program called VAMPSET available for configuration and setting of VAMP devices. Please download the latest VAMPSET.exe from our web page www.vamp.fi. For more information about the VAMPSET software, please refer to the user's manual with the code VMV.EN0xx. Also the VAMPSET user's manual is available at our web site.

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1. Introduction

This part of the user's manual describes the measurement and alarm functions, provides a few application examples and contains technical data. This part of the manual also includes the operating instructions.

Mounting and commissioning instructions are given in a separate mounting and commissioning manual VMMC.EN0xx.

The power-monitoring unit VAMP 260 is an integrated monitoring device. Through numerical signal processing the device produces large amounts of important information. The device utilizes the latest technology and thus it offers many features, so far not found in corresponding devices.

The device measures the phase currents and the phase-to-phase voltages or phase-to-neutral voltages. Besides these directly measured data the VAMP 260 calculates much data about the state of the power network.

1.1. Main features

- Fully digital signal handling with a powerful 16-bit microprocessor and high measuring accuracy on all setting ranges due to an accurate 16-bit A/D conversion technique.
- Eight programmable alarm stages
- Wide setting ranges for the alarm stages.
- The unit can be matched to the requirements of the application by disabling functions not needed.
- Flexible control and blocking possibilities due to the six digital signal control inputs (DI).
- Easy adaptability of the unit to various substations and alarm systems due to a flexible signal-grouping matrix in the unit.
- Recording of events and fault values into an event register, from which data can be read via the key pad and the display or by means of the PC based VAMPSET user interface.
- Handy configuration, parameterization and reading of information via the user panel or with VAMPSET user interface.
- Easy connection to power plant automation system due to a versatile serial connection and several available communication protocols.
- Built-in self-regulating dc/dc converter for auxiliary power supply from any source within the range 40 to 260 V dc or ac, optionally 24 V dc.
- Built-in disturbance recorder
- Four programmable analog outputs (Option)

1.2. Principles of the numerical measuring technique

The power-monitoring unit VAMP 260 is fully designed using numerical technology. This means that all signal filtering, measuring and control functions are implemented through digital processing.

The numerical technique used in the unit is primarily based on an adapted fast Fourier transformation (FFT), in which the number of calculations (multiplications and additions) required to filter out the measuring quantities remains reasonable.

By using synchronized sampling of the measured signal (voltage or current) and a sample rate according to the 2^n series, the FFT technique leads to a solution, which can be realized with just a 16-bit microcontroller, without using a separate DSP (Digital Signal Processor).

The synchronized sampling means an even number of 2^n samples per period, e.g. 16 or 32 samples per period. This means that the frequency must be measured and the number of samples per period must be controlled accordingly, so that the number of samples per period remains constant, if the frequency changes.

2. Main Functions

2.1. Event log

Event log is a buffer of event codes and time stamps including date and time. For example each start-on, start-off, trip-on or trip-off of any alarm has a unique event number code. Such a code and the corresponding time stamp is called an event. The event codes are listed in a separate document VAMP2xx_Events.pdf.

As an example of information included with a typical event an Programmable stage Trip.

EVENT	Description	Local panel	Communication protocols
Code: 46E2	Channel 46, event 2	Yes	Yes
Prg1 trip on	Event text	Yes	No
1.25 x In	Fault value	Yes	No
2007-01-31	Date	Yes	Yes
08:35:13.413	Time	Yes	Yes

Events are the major data for a SCADA system. SCADA systems are reading events using any of the available communication protocols. Event log can also be scanned using the front panel or using VAMPSET. With VAMPSET the events can be stored to a file especially in case the unit is not connected to any SCADA system.

Only the latest event can be read when using communication protocols or VAMPSET. Every reading increments the internal read pointer to the event buffer. (In case of communication error, the latest event can be reread any number of times using an other parameter.) On the local panel scanning the event buffer back and forth is possible.

Event enabling/masking

In case of an uninteresting event, it can be masked, which prevents the particular event(s) to be written in the event buffer.

There are room for 50 latest events in the event buffer. The oldest one will be overwritten, when a new event does occur. The shown resolution of a time stamp is one millisecond, but the actual resolution depends of the particular function creating the event. The absolute accuracy of all time stamps depends on the time synchronizing of the device. See chapter **2.6** for system clock synchronizing.

Event buffer overflow

The normal procedure is to poll events from the device all the time. If this is not done, the event buffer will eventually overflow. On the local screen this is indicated with string "OVF" after the event code.

Setting parameters for events

Parameter	Value	Description	Note
Count		Number of events	
ClrEn	– Clear	Clear event buffer	Set
Order	Old-New New-Old	Order of the event buffer for local display	Set
FVSca	PU Pri	Scaling of event fault value Per unit scaling Primary scaling	Set
Display Alarms	On Off	Alarm pop-up display is enabled No alarm display	Set
FORMAT OF EVENTS ON THE LOCAL DISPLAY			
Code: CHENN		CH = event channel, NN=event code	
Event description		Event channel and code in plain text	
yyyy-mm-dd		Date (for available date formats see chapter 2.6)	
hh:mm:ss.nnn		Time	

2.2. Disturbance recorder

The disturbance recorder can be used to record all the measured signals, that is, currents, voltages and the status information of digital inputs (DI) and digital outputs (DO).

Triggering the recorder

The recorder can be triggered by any start or trip signal from any protection stage or by a digital input. The triggering signal is selected in the output matrix (vertical signal DR). The recording can also be triggered manually. All recordings are time stamped.

Reading recordings

The recordings can be uploaded, viewed and analysed with the VAMPSET program. The recording is in COMTRADE format. This means that also other programs can be used to view and analyse the recordings made by the relay.

For more details, please see a separate VAMPSET manual.

Number of channels

At the maximum, there can be 12 recordings, and the maximum selection of channels in one recording is also 12 (limited in waveform recording). The digital inputs reserve one channel (includes all the inputs). Also the digital outputs reserve one channel (includes all the outputs). If digital inputs and outputs are recorded, there will be still 10 channels left for analogue waveforms.

Disturbance recorder parameters

Parameter	Value	Unit	Description	Note
Mode	 Saturated Overflow		Behaviour in memory full situation: No more recordings are accepted The oldest recorder will be overwritten	Set
SR	 32/cycle 16/cycle 8/cycle 1/10ms 1/20ms 1/200ms 1/1s 1/5s 1/10s 1/15s 1/30s 1/1min		Sample rate Waveform Waveform Waveform One cycle value *) One cycle value **) Average Average Average Average Average Average Average	Set
Time		s	Recording length	Set
PreTrig		%	Amount of recording data before the trig moment	Set
MaxLen		s	Maximum time setting. This value depends on sample rate, number and type of the selected channels and the configured recording length.	
Status	 – Run Trig FULL		Status of recording Not active Waiting a triggering Recording Memory is full in saturated mode	
ManTrig	 – Trig		Manual triggering	Set

Parameter	Value	Unit	Description	Note
ReadyRec	n/m		n = Available recordings m = maximum number of recordings The value of 'm' depends on sample rate, number and type of the selected channels and the configured recording length.	
AddCh			Add one channel. Maximum simultaneous number of channels is 12.	Set
	IL1, IL2, IL3		Phase current	
	U12, U23, U31		Line-to-line voltage	
	UL1, UL2, UL3		Phase-to-neutral voltage	
	Uo		Zero sequence voltage	
	f		Frequency	
	P, Q, S		Active, reactive, apparent power	
	P.F.		Power factor	
	CosFii		cosφ	
	IoCalc		Phasor sum Io = ($\underline{I}$L1+$\underline{I}$L2+$\underline{I}$L3)/3	
	I1		Positive sequence current	
	I2		Negative sequence current	
	I2/I1		Relative current unbalance	
	I2/In		Current unbalance [xI_N]	
	U1		Positive sequence voltage	
	U2		Negative sequence voltage	
	U2/U1		Relative voltage unbalance	
	IL		Average (IL1 + IL2 + IL3)/3	
	Uphase		Average (UL1 + UL2 + UL3)/3	
	Uline		Average (U12 + U23 + U31)/3	
	DO		Digital outputs	
	DI		Digital inputs	
	TanFii		tanφ	
	Prms		Active power rms value	
	Qums		Reactive power rms value	
	Srms		Apparent power rms value	
	THDIL1		Total harmonic distortion of IL1	
	THDIL2		Total harmonic distortion of IL2	
	THDIL3		Total harmonic distortion of IL3	

	THDUa		Total harmonic distortion of input Ua	
	THDUb		Total harmonic distortion of input Ub	
	THDUc		Total harmonic distortion of input Uc	
	IL1RMS		IL1 RMS for average sampling	
	IL2RMS		IL2 RMS for average sampling	
	IL3RMS		IL3 RMS for average sampling	
	ILmin		Minimum of phase currents	
	ILmax		Maximum of phase currents	
	ULLmin		Minimum of line voltages	
	ULLmax		Maximum of line voltages	
	ULNmin		Minimum of phase voltages	
	ULNmax		Maximum of phase voltages	
ClrCh	– Clear		Remove all channels	Set
(Ch)			List of selected channels	

Set = An editable parameter (password needed)

*) This is the fundamental frequency rms value of one cycle updated every 10 ms.

**) This is the fundamental frequency rms value of one cycle updated every 20 ms.

2.3. Voltage sags and swells

The power quality of electrical networks has become increasingly important. The sophisticated loads (e.g. computers etc.) require uninterruptible supply of “clean” electricity. VAMP protection platform provides many power quality functions that can be used to evaluate, monitor and alarm on the basis of the quality. One of the most important power quality functions are voltage sag and swell monitoring.

VAMP provides separate monitoring logs for sags and swells. The voltage log is trigged, if any voltage input either goes under the sag limit (U<) or exceeds the swell limit (U>). There are four registers for both sags and swells in the fault log. Each register will have start time, phase information, duration, minimum, average, maximum voltage values of each sag and swell event. Furthermore, there are total number of sags and swells counters as well as total timers for sags and swells.

The voltage power quality functions are located under the submenu “U”.

Setting parameters of sags and swells monitoring:

Parameter	Value	Unit	Default	Description
U>	20 … 150	%	110	Setting value of swell limit
U<	10 … 120	%	90	Setting value of sag limit
Delay	0.04 … 1.00	s	0.06	Delay for sag and swell detection
SagOn	On; Off	-	On	Sag on event
SagOff	On; Off	-	On	Sag off event
SwelOn	On; Off	-	On	Swell on event
SwelOf	On; Off	-	On	Swell off event

Recorded values of sags and swells monitoring:

	Parameter	Value	Unit	Description
Recorded values	Count		-	Cumulative sag counter
	Total		-	Cumulative sag time counter
	Count		-	Cumulative swell counter
	Total		-	Cumulative swell time counter
Sag/ swell logs 1…4	Date		-	Date of the sag/swell
	Time		-	Time stamp of the sag/swell
	Type		-	Voltage inputs that had the sag/swell
	Time		s	Duration of the sag/swell
	Min1		%Un	Minimum voltage value during the sag/swell in the input 1
	Min2		%Un	Minimum voltage value during the sag/swell in the input 2
	Min3		%Un	Minimum voltage value during the sag/swell in the input 3
	Ave1		%Un	Average voltage value during the sag/swell in the input 1
	Ave2		%Un	Average voltage value during the sag/swell in the input 2
	Ave3		%Un	Average voltage value during the sag/swell in the input 3
	Max1		%Un	Maximum voltage value during the sag/swell in the input 1
	Max2		%Un	Maximum voltage value during the sag/swell in the input 2

	Max3		%Un	Maximum voltage value during the sag/swell in the input 3

2.4. Voltage interruptions

The unit includes a simple function to detect voltage interruptions. The function calculates the number of voltage interruptions and the total time of the voltage-off time within a given calendar period. The period is based on the real time clock of the device. The available periods are:

- 8 hours, 00:00 – 08:00, 08:00 – 16:00, 16:00 – 24:00
- one day, 00:00 – 24:00
- one week, Monday 00:00 – Sunday 24:00
- one month, the first day 00:00 – the last day 24:00
- one year, 1st January 00:00 – 31st December 24:00

After each period, the number of interruptions and the total interruption time are stored as previous values. The interruption counter and the total time are cleared for a new period. The old previous values are overwritten.

The voltage interruption is based on the value of the positive sequence voltage U_1 and a user given limit value. Whenever the measured U_1 goes below the limit, the interruption counter is increased, and the total time counter starts increasing.

Shortest recognized interruption time is 40 ms. If the voltage-off time is shorter it may be recognized depending on the relative depth of the voltage dip.

If the voltage has been significantly over the limit $U_1<$ and then there is a small and short under-swing, it will not be recognized (Figure 2.4-1).

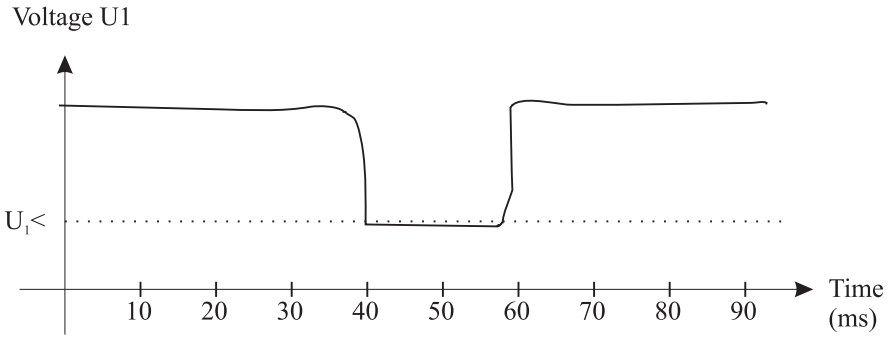


Figure 2.4-1. A short voltage interruption which is probably not recognized

On the other hand, if the limit $U_1<$ is high and the voltage has been near this limit, and then there is a short but very deep dip, it will be recognized (Figure 2.4-2).

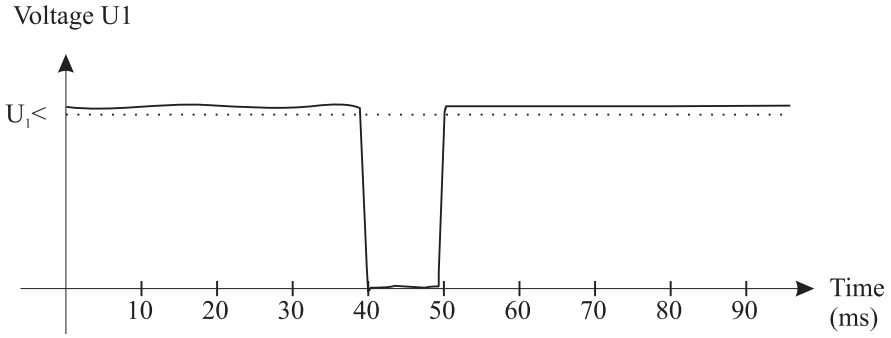


Figure 2.4-2. A short voltage interrupt that will be recognized

Setting parameters of the voltage sag measurement function:

Parameter	Value	Unit	Default	Description
U1<	10.0… 120.0	%	64	Setting value
Period	8h Day Week Month	-	Month	Length of the observation period
Date		-	-	Date
Time		-	-	Time

Measured and recorded values of voltage sag measurement function:

	Parameter	Value	Unit	Description
Measured value	Voltage	LOW; OK	-	Current voltage status
	U1		%	Measured positive sequence voltage
Recorded values	Count		-	Number of voltage sags during the current observation period
	Prev		-	Number of voltage sags during the previous observation period
	Total		s	Total (summed) time of voltage sags during the current observation period
	Prev		s	Total (summed) time of voltage sags during the previous observation period

2.5. Energy pulse outputs

The device can be configured to send a pulse whenever certain amount of energy has been imported or exported. The basic idea is presented in Figure 2.5-1. Principle of energy pulses. Each time the energy level reaches the pulse size, an output relay is activated and it will stay active as long as defined by a pulse duration setting.

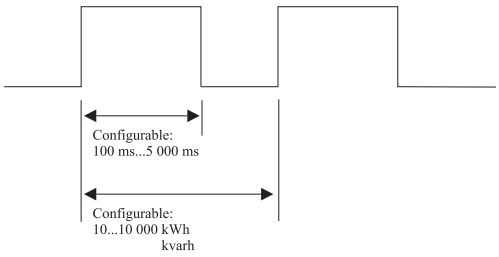


Figure 2.5-1. Principle of energy pulses

The device has four energy pulse outputs. The channels are:

- Active exported energy
- Reactive exported energy
- Active imported energy
- Reactive imported energy

Each channel can be connected to any combination of the nine output relays. The connection is configured in the output matrix. The parameters for the energy pulses can be found in the E menu under the submenus E-PULSE SIZES and E-PULSE DURATION.

Energy pulse function parameters:

	Parameter	Value	Unit	Description
E-PULSE SIZES	E+	10 … 10 000	kWh	Pulse size of active exported energy
	Eq+	10 … 10 000	kvarh	Pulse size of reactive exported energy
	E-	10 … 10 000	kWh	Pulse size of active imported energy
	Eq-	10 … 10 000	kvarh	Pulse size of reactive imported energy
E-PULSE DURATION	E+	100 … 5000	ms	Pulse length of active exported energy
	Eq+	100 … 5000	ms	Pulse length of reactive exported energy
	E-	100 … 5000	ms	Pulse length of active imported energy
	Eq-	100 … 5000	ms	Pulse length of reactive imported energy

Scaling examples

Example 1.

Average active exported power is 250 MW.
Peak active exported power is 400 MW.
Pulse size is 250 kWh.
The average pulse frequency will be 250/0.250 = 1000 pulses/h.
The peak pulse frequency will be 400/0.250 = 1600 pulses/h.
Set pulse length to 3600/1600 – 0.2 = 2.0 s or less.
The trip relay lifetime will be $50x10^6$/1000 h = 6 a.
This is not a practical scaling example unless an output relay lifetime of about six years is accepted.

Example 2.

Average active exported power is 100 MW.
Peak active exported power is 800 MW.
Pulse size is 400 kWh.
The average pulse frequency will be 100/0.400 = 250 pulses/h.
The peak pulse frequency will be 800/0.400 = 2000 pulses/h.
Set pulse length to 3600/2000 – 0.2 = 1.6 s or less.
The trip relay lifetime will be $50x10^6$/250 h = 23 a.

Example 3.

Average active exported power is 20 MW.
Peak active exported power is 70 MW.
Pulse size is 60 kWh.
The average pulse frequency will be 25/0.060 = 416.7 pulses/h.
The peak pulse frequency will be 70/0.060 = 1166.7 pulses/h.
Set pulse length to 3600/1167 – 0.2 = 2.8 s or less.
The trip relay lifetime will be $50x10^6$/417 h = 14 a.

Example 4.

Average active exported power is 1900 kW.
Peak active exported power is 50 MW.
Pulse size is 10 kWh.
The average pulse frequency will be 1900/10 = 190 pulses/h.
The peak pulse frequency will be 50000/10 = 5000 pulses/h.
Set pulse length to 3600/5000 – 0.2 = 0.5 s or less.
The trip relay lifetime will be $50x10^6$/190 h = 30 a.

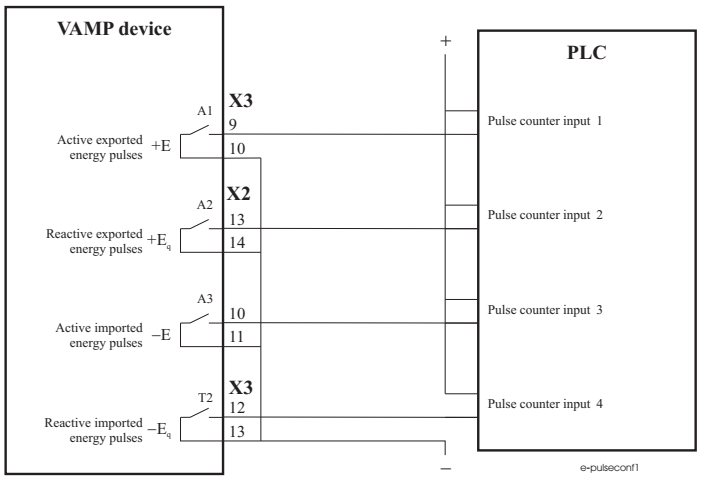


Figure 2.5-2. Application example of wiring the energy pulse outputs to a PLC having common plus and using an external wetting voltage

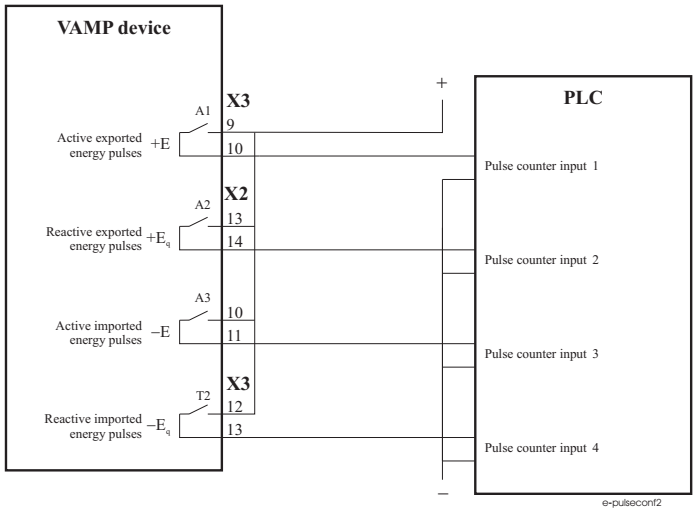


Figure 2.5-3. Application example of wiring the energy pulse outputs to a PLC having common minus and using an external wetting voltage

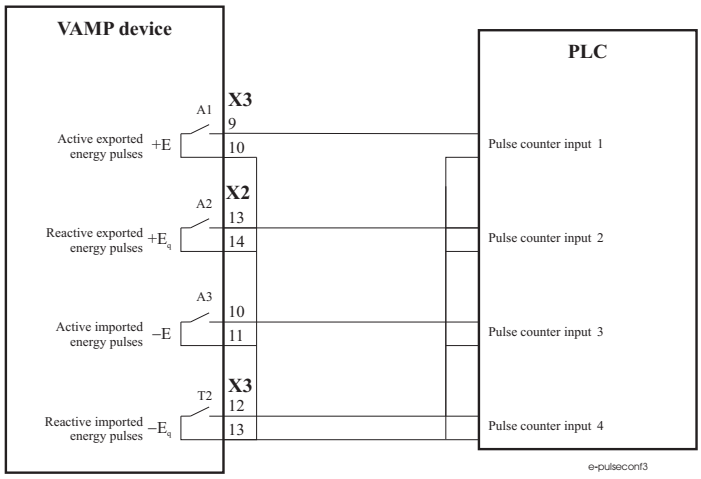


Figure 2.5-4. Application example of wiring the energy pulse outputs to a PLC having common minus and an internal wetting voltage

2.6. System clock and synchronization

The internal clock of the unit is used to time stamp events and disturbance recordings.

The system clock should be externally synchronised to get comparable event time stamps for all the units in the system.

The synchronizing is based on the difference of the internal time and the synchronising message or pulse. This deviation is filtered and the internal time is corrected softly towards a zero deviation.

Adapting auto adjust

During tens of hours of synchronizing the device will learn its average error and starts to make small corrections by itself. The target is that when the next synchronizing message is received, the deviation is already near zero. Parameters "AAIntv" and "AvDrft" will show the adapted correction time interval of this ±1 ms auto-adjust function.

Time drift correction without external sync

If any external synchronizing source is not available and the system clock has a known steady drift, it is possible to roughly correct the clock error by editing the parameters "AAIntv" and "AvDrft". The following equation can be used if the previous "AAIntv" value has been zero.

$$AAIntv = \frac{604.8}{DriftInOneWeek}$$

If the auto-adjust interval "AAIntv" has not been zero, but further trimming is still needed, the following equation can be used to calculate a new auto-adjust interval.

$$AAIntv_{NEW} = \frac{1}{\frac{1}{AAIntv_{PREVIOUS}} + \frac{DriftInOneWeek}{604.8}}$$

The term *DriftInOneWeek*/604.8 may be replaced with the relative drift multiplied by 1000, if some other period than one week has been used. For example if the drift has been 37 seconds in 14 days, the relative drift is 37*1000/(14*24*3600) = 0.0306 ms/s.

Example 1.

If there has been no external sync and the units clock is leading sixty-one seconds a week and the parameter AAIntv has been zero, the parameters are set as

$$AvDrft = Lead$$

$$AAIntv = \frac{604.8}{61} = 9.9s$$

With these parameter values the system clock corrects itself with –1 ms every 9.9 seconds which equals –61.091 s/week.

Example 2.

If there is no external sync and the units clock has been lagging five seconds in nine days and the AAIntv has been 9.9 s, leading, then the parameters are set as

$$AAIntv_{NEW} = \frac{1}{\frac{1}{9.9} - \frac{5000}{9 \cdot 24 \cdot 3600}} = 10.6$$

$$AvDrft = Lead$$

NOTE! When the internal time is roughly correct – deviation is less than four seconds – any synchronizing or auto-adjust will never turn the clock backwards. Instead, in case the clock is leading, it is softly slowed down to maintain causality.

System clock parameters

Parameter	Value	Unit	Description	Set
Date			Current date	Set
Time			Current time	Set
Style	 y–d–m d.m.y m/d/y		Date format Year-Month-Day Day.Month.Year Month/Day/Year	Set
SyncDI	 – DI1 ... DI6		The digital input used for clock synchronisation. DI not used for synchronizing Minute pulse input	***)
TZone	–12.00 ... +14.00 *)		UTC time zone for SNTP synchronization. Note: This is a decimal number. For example for state of Nepal the time zone 5:45 is given as 5.75	Set
DST	No Yes		Daylight saving time for SNTP	Set

Parameter	Value	Unit	Description	Set
SySrc	 Internal DI SNTP SpaBus ModBus ProfibusDP IEC-103 DNP3		Clock synchronisation source No sync recognized since 200 s Digital input Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync Protocol sync	
MsgCnt	0 ... 65535, 0 ... etc.		The number of received synchronisation messages or pulses	
Dev	±32767	ms	Latest time deviation between the system clock and the received synchronization	
SyOS	±10000.000	s	Synchronisation correction for any constant error in the synchronizing source. A positive value will compensate a lagging external sync and communication delays. A negative value will compensate any leading offset of the external synch source.	Set
AAIntv	±10000	s	Adapted auto adjust interval for 1 ms correction	Set **)
AvDrft	Lead Lag		Adapted average clock drift sign	Set **)
FilDev	±125	ms	Filtered synchronisation deviation	

Set = An editable parameter (password needed).

*) Astronomically a range –11 ... +12 h would be enough, but for political and geographical reasons a larger range is needed.

**) If external synchoronization is used this parameter will be set automatically.

***) Set the DI delay to its minimum and the polarity such that the leading edge is the synchronizing edge.

2.7. Running hour counter

This function calculates the total active time of the selected digital input, virtual I/O or output matrix output signal. The resolution is ten seconds.

Running hour counter parameters

Parameter	Value	Unit	Description	Set
Runh	0 ... 876000	h	Total active time, hours Note: The label text "Runh" can be edited with VAMPSET.	(Set)
	0 ... 3599	s	Total active time, seconds	(Set)
Starts	0 ... 65535		Activation counter	(Set)
Status	Stop Run		Current status of the selected digital signal	
DI	 - DI1 ...DI6, VI1...VI4, LedAl, LedTr, LedA, LedB, LedC, LedDR VO1...VO6		Select the supervised signal None Physical inputs Virtual inputs Output matrix out signal Al Output matrix out signal Tr Output matrix out signal LA Output matrix out signal LB Output matrix out signal LC Output matrix out signal DR Virtual outputs	Set
Started at			Date and time of the last activation	
Stopped at			Date and time of the last inactivation	

Set = An editable parameter (password needed).
(Set) = An informative value which can be edited as well.

2.8. Timers

The VAMP protection platform includes four settable timers that can be used in many different applications that require actions based on time. Each timer has its own settings. The selected on time and off time is set and then the activation of the timer can be set to be as daily or different week days (See the setting parameters for details). The timer outputs are available for logic functions, block and output matrix.

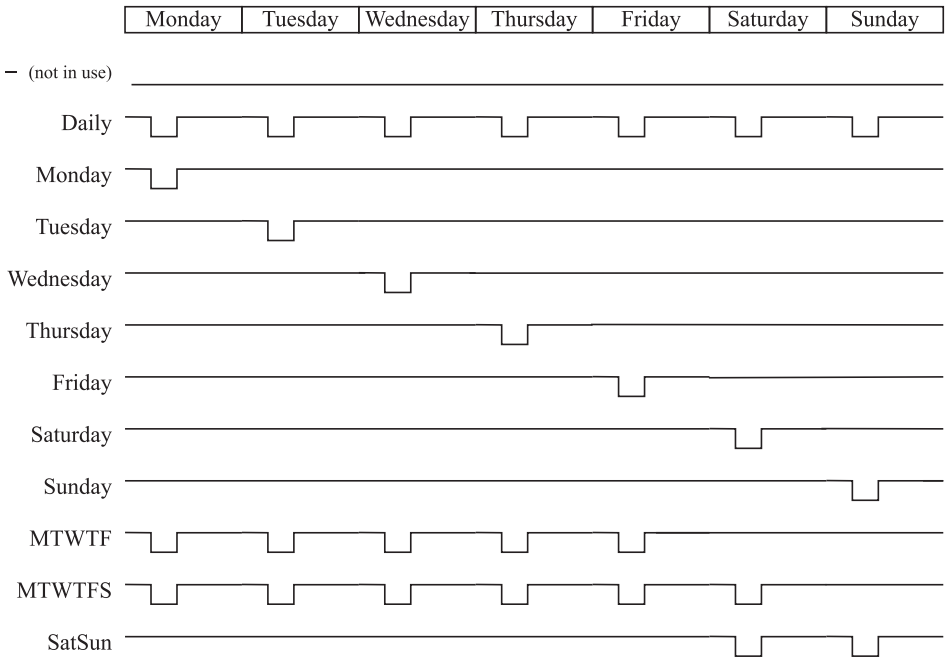


Figure 2.8-1. Timer output sequence in different modes.

The user can force any timer, which is in use, on or off. The forcing is done by writing a new status value. No forcing flag is needed as in forcing i.e. the output relays.

The forced time is valid until the next forcing or until the next reversing timed act from the timer itself.

The status of each timer is stored in non-volatile memory when the auxiliary power is switched off. At start up, the status of each timer is recovered.

Setting parameters of timers:

Parameter	Value	Unit	Default	Description
On	hh:mm:ss	-	07:00:00	Activation time of the timer
Off	hh:mm:ss	-	16:00:00	De-activation time of the timer
Mode				For each four timers there are 12 different modes available:
	-;	-	-	The timer is off and not running. The output is off i.e. 0 all the time.
	Daily;			The timer switches on and off once every day.
	Monday;			The timer switches on and off every Monday.
	Tuesday;			The timer switches on and off every Tuesday.
	Wednesday;			The timer switches on and off every Wednesday.
	Thursday;			The timer switches on and off every Thursday.
	Friday;			The timer switches on and off every Friday.
	Saturday;			The timer switches on and off every Saturday.
	Sunday;			The timer switches on and off every Sunday.
	MTWTF;			The timer switches on and off every day except Saturdays and Sundays
	MTWTFS;			The timer switches on and off every day except Sundays.
	SatSun;			The timer switches on and off every Saturday and Sunday.
SagOn	On; Off	-	On	Sag on event
SagOff	On; Off	-	On	Sag off event
SwelOn	On; Off	-	On	Swell on event
SwelOf	On; Off	-	On	Swell off event

2.9. Programmable stages (99)

For special applications the user can built his own protection stages by selecting the supervised signal and the comparison mode.

The following parameters are available:

- **Priority**
  If operation times less than 60 milliseconds are needed select 10 ms. For operation times under one second 20 ms is recommended. For longer operation times and THD signals 100 ms is recommended.
- **Link**
  The name of the supervised signal (see table below).
- **Cmp**
  Compare mode. '>' for over or '<' for under comparison.
- **Pick-up**
  Limit of the stage. The available setting range and the unit depend on the selected signal.
- **t**
  Definite time operation delay
- **Hyster**
  Dead band (hysteresis)
- **NoCmp**
  Only used with compare mode under ('<'). This is the limit to start the comparison. Signal values under NoCmp are not regarded as fault.

Available signals to be supervised by the programmable stages

IL1, IL2, IL3	Phase currents
U12, U23, U31	Line-to-line voltages
UL1, UL2, UL3	Phase-to-ground voltages
Uo	Zero-sequence voltage
f	Frequency
P	Active power
Q	Reactive power
S	Apparent power
CosFii	Cosine φ
IoCalc	Phasor sum $\underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$
I1	Positive sequence current
I2	Negative sequence current
I2/I1	Relative negative sequence current
I2/IN	Negative sequence current in pu
U1	Positive sequence voltage
U2	Negative sequence voltage
U2/U1	Relative negative sequence voltage
IL	Average $(I_{L1} + I_{L2} + I_{L3})/3$
Uphase (U_{LN})	Average $(U_{L1} + U_{L2} + U_{L3})/3$
Uline (U_{LL})	Average $(U_{12} + U_{23} + U_{31})/3$
TanFii	Tangent φ [=tan(arccosφ)]
Prms	Active power rms vvalue
Qrms	Reactive power rms value
Srms	Apparent power rms value
THDIL1	Total harmonic distortion of I_{L1}
THDIL2	Total harmonic distortion of I_{L2}
THDIL3	Total harmonic distortion of I_{L3}
THDUa	Total harmonic distortion of input U_a
THDUc	Total harmonic distortion of input U_b
THDUb	Total harmonic distortion of input U_c
IL1RMS	Phase current I_{L1} RMS value
IL2RMS	Phase current I_{L2} RMS value
IL3RMS	Phase current I_{L3} RMS value
ILmin, ILmax	Minimum and maximum of phase currents
ULLmin, ULLmax	Minimum and maximum of line voltages
ULNmin, ULNmax	Minimum and maximum of phase voltages

Eight independent stages

The relay has eight independent programmable stages. Each programmable stage can be enabled or disabled to fit the intended application.

Setting groups

There are two settings groups available. Switching between setting groups can be controlled by digital inputs, virtual inputs (mimic display, communication, logic) and manually.

There are two identical stages available with independent setting parameters.

Parameters of the programmable stages PrgN (99)

Parameter	Value	Unit	Description	Note
Status	- Blocked Start Trip		Current status of the stage	 F F
SCntr			Cumulative start counter	C
TCntr			Cumulative trip counter	C
SetGrp	1 or 2		Active setting group	Set
SGrpDI	 - DIx VIx LEDx VOx		Digital signal to select the active setting group None Digital input Virtual input LED indicator signal Virtual output	Set
Force	Off On		Force flag for status forcing for test purposes. This is a common flag for all stages and output relays, too. Automatically reset by a 5-minute timeout.	Set
Link	(See table above)		Name for the supervised signal	Set
(See table above)			Value of the supervised signal	
Cmp	 > <		Mode of comparison Over protection Under protection	Set
Pickup			Pick up value scaled to primary level	
Pickup		pu	Pick up setting in pu	Set
t		s	Definite operation time.	Set
Hyster		%	Dead band setting	Set
NoCmp		pu	Minimum value to start under comparison. (Mode='<')	Set

Set = An editable parameter (password needed)

C = Can be cleared to zero

F = Editable when force flag is on

Recorded values of the latest eight faults

There are detailed information available of the eight latest faults: Time stamp, fault value and elapsed delay.

Recorded values of the programmable stages PrgN (99)

Parameter	Value	Unit	Description
	yyyy-mm-dd		Time stamp of the recording, date
	hh:mm:ss.ms		Time stamp, time of day
Flt		pu	Fault value
EDly		%	Elapsed time of the operating time setting. 100% = trip
SetGrp	1 2		Active setting group during fault

2.10. Self-supervision

The functions of the microcontroller and the associated circuitry as well as the program execution are supervised by means of a separate watchdog circuit. Besides supervising the unit the watchdog circuit attempts to restart the micro-controller in a fault situation. If the restarting fails the watchdog issues a self-supervision alarm because of a permanent unit fault.

When the watchdog circuit detects a permanent fault it always blocks any control of the other output relays, except for the self-supervision output relay.

3. Measurement functions

All the direct measurements are based on fundamental frequency values. (The exceptions are frequency and instantaneous current for arc protection.) The figure shows a current waveform and the corresponding fundamental frequency component, second harmonic and rms value in a special case, when the current deviates significantly from a pure sine wave.

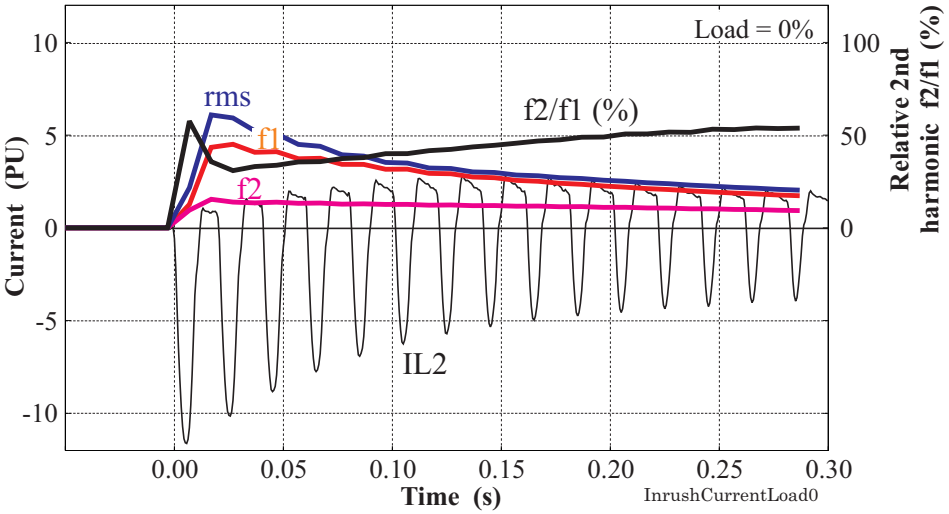


Figure 3-1 Example of various current values of a transformer inrush current.

3.1. Measurement accuracy

The specified frequency range for all measurements except frequency is 45 Hz – 65 Hz.

Phase current inputs I_{L1}, I_{L2}, I_{L3}

Measuring range		0 – 50 xI_N
Inaccuracy	I ≤ 7.5 A	±0.5 % of value or ±0.3 % of I_N
	I > 7.5 A	±3 % of value
Squelch level		0.001 x I_N

The rated input I_N is 5 A or 1 A. It is specified in the order code of the relay.

Voltage inputs U_a, U_b, U_c

The usage of voltage inputs depends on the configuration parameter voltage measurement mode (chapter 3.9). For example, U_c is the input for U_{31} if the mode "3LL" is selected but in mode "3LN" the same input is used for phase-to-neutral voltage U_{L3}.

Measuring range	0 – 260 V
Inaccuracy	±0.5 % or ±0.3 V
Squelch level	0.1 V

Frequency

Measuring range	16 Hz – 75 Hz
Inaccuracy	±10 mHz

The frequency is measured from voltage inputs U_a and/or U_b.

Power measurements P, Q, S

Inaccuracy	|PF| > 0.5	±1 % of value or ±3 VA_{SEC}

Power factor, cosφ, tanφ

Inaccuracy	|PF|>0.5	±2° or ±0.02

Energy counters E+, Eq+, E-, Eq-

Inaccuracy	|PF| > 0.5	±1 % of value or ±3 $Wh_{SECONDARY}$/1 h

THD and harmonics

Inaccuracy	I, U > 0.1 PU	±2 % units
Update rate		At least once a second

3.2. Power calculation

The power calculation in VAMP devices are dependent on the voltage measurement mode, see chapter 3.1. The equations used for power calculations are described in this chapter.

The relay is connected to line-to-line voltages

When the relay is connected to line-to-line voltages, the voltage measurement mode is set to equal to "3LL". The following Aron equation is used for power calculation.

$\overline{S} = \overline{U}_{12} \cdot \bar{I}^*_{L1} - \overline{U}_{23} \cdot \bar{I}^*_{L3}$, where

$\overline{S}$ = Three phase power phasor

$\overline{U}_{12}$ = Measured voltage phasor corresponding the fundamental frequency voltage between phases L1 and L2.

$\bar{I}^*_{L1}$ = Complex conjugate of the measured phase L1 fundamental frequency current phasor.

$\overline{U}_{23}$ = Measured voltage phasor corresponding the fundamental frequency voltage between phases L2 and L3.

$\bar{I}^*_{L3}$ = Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power and reactive power are calculated as follows

$$S = \left|\overline{S}\right|$$

$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

The relay is connected to line-to-neutral voltage

When the relay is connected to line-to-neutral voltages, the voltage measurement mode is set to equal to "3LN". The following equation is used for power calculation.

$\overline{S} = \overline{U}_{L1} \cdot \overline{I}^{*}_{L1} + \overline{U}_{L2} \cdot \overline{I}^{*}_{L2} + \overline{U}_{L3} \cdot \overline{I}^{*}_{L3}$, where

$\overline{S}$	=	Three phase power phasor
$\overline{U}_{L1}$	=	Measured voltage phasor corresponding the fundamental frequency voltage of phase L1.
$\overline{I}^{*}_{L1}$	=	Complex conjugate of the measured phase L1 fundamental frequency current phasor.
$\overline{U}_{L2}$	=	Measured voltage phasor corresponding the fundamental frequency voltage of phase L2.
$\overline{I}^{*}_{L2}$	=	Complex conjugate of the measured phase L2 fundamental frequency current phasor.
$\overline{U}_{L3}$	=	Measured voltage phasor corresponding the fundamental frequency voltage of phase L3.
$\overline{I}^{*}_{L3}$	=	Complex conjugate of the measured phase L3 fundamental frequency current phasor.

Apparent power, active power and reactive power are calculated similarly as with line-to-line voltages

$$S = \left|\overline{S}\right|$$

$$P = real(\overline{S})$$

$$Q = imag(\overline{S})$$

$$\cos\varphi = \frac{P}{S}$$

3.3. Direction of power and current

Figure 3.3-1 shows the concept of three phase current direction and sign of cosφ and power factor PF. Figure 3.3-2 shows the same concepts, but on a PQ-power plane.

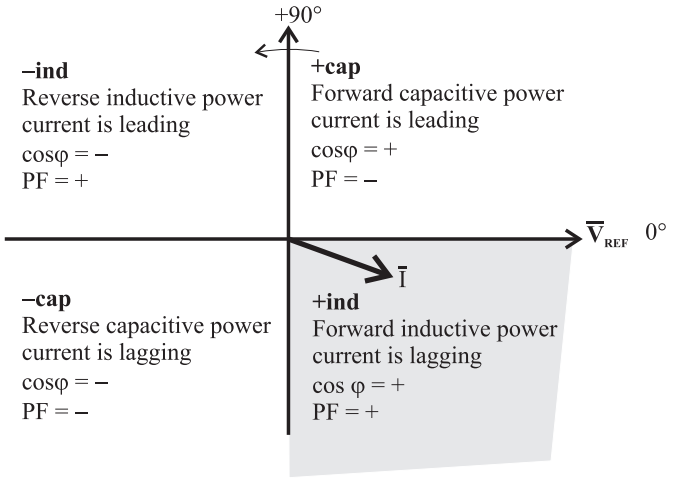


Figure 3.3-1 Quadrants of voltage/current phasor plane

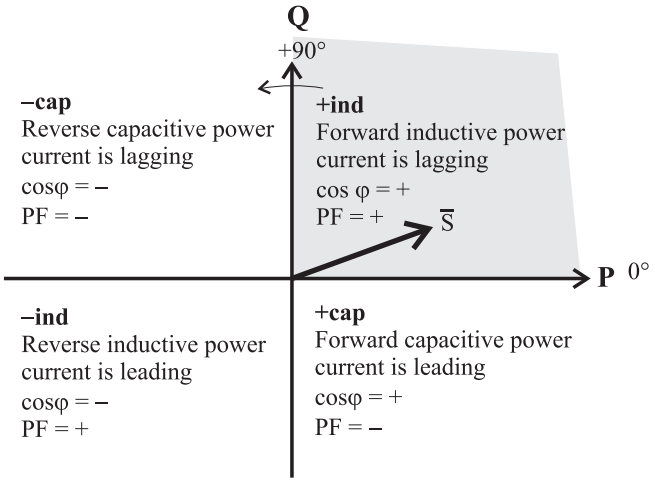


Figure 3.3-2 Quadrants of power plane

Table of power quadrants

Power quadrant	Current related to voltage	Power direction	cosφ	Power factor PF
+ inductive	Lagging	Forward	+	+
+ capacitive	Leading	Forward	+	–
– inductive	Leading	Reverse	–	+
– capacitive	Lagging	Reverse	–	–

3.4. Harmonics and Total Harmonic Distortion (THD)

The device calculates the THDs as percentage of the base frequency for currents and voltages.

The device calculates the harmonics from the 2nd to the 15th of phase currents and voltages. (The 17th harmonic component will also be shown partly in the value of the 15th harmonic component. This is due to the nature of digital sampling.)

The harmonic distortion is calculated using equation

$$THD = \frac{\sqrt{\sum_{i=2}^{15} h_i^2}}{h_1}$$, where

h_1 = Fundamental value

$h_{2...15}$ = Harmonics

Example

h_1 = 100 A

h_3 = 10 A

h_7 = 3 A

h_{11} = 8 A

$$THD = \frac{\sqrt{10^2 + 3^2 + 8^2}}{100} = 13.2\%$$

For reference the RMS value is:

$$RMS = \sqrt{100^2 + 10^2 + 3^2 + 8^2} = 100.9A$$

Another way to calculate THD is to use the RMS value as reference instead of the fundamental frequency value. In the example above the result would then be 13.0 %.

3.5. RMS values

RMS currents

PMU calculates the RMS value of each phase current. The minimum and the maximum of RMS values are recorded and stored (see chapter 3.7).

$$I_{rms} = \sqrt{I_{f1}^{\ 2} + I_{f2}^{\ 2} + ... + I_{f15}^{\ 2}}$$

RMS voltages

PMU calculates the RMS value of each voltage input. The minimum and the maximum of RMS values are recorded and stored (see chapter 3.7).

$$U_{rms} = \sqrt{U_{f1}^{\ 2} + U_{f2}^{\ 2} + ... + U_{f15}^{\ 2}}$$

Apparent RMS power (S_{RMS})

PMU calculates the RMS value of apparent power (S). The minimum and the maximum of RMS values are recorded and stored (see chapter 3.7).

$S_{rms} = I_{rms} * U_{rms}$

3.6. Demand values

The unit calculates average i.e. demand values of phase currents I_{L1}, I_{L2}, I_{L3} and power values S, P and Q. The demand time is configurable from 10 minutes to 30 minutes with parameter "Demand time".

Demand value parameters

Parameter	Value	Unit	Description	Note
Time	10 ... 30	min	Demand time (averaging time)	Set
Fundamental frequency values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	
Pda		kW	Demand of active power P	
PFda			Demand of power factor PF	
Qda		kvar	Demand of reactive power Q	
Sda		kVA	Demand of apparent power S	
RMS values				
IL1da		A	Demand of phase current IL1	
IL2da		A	Demand of phase current IL2	
IL3da		A	Demand of phase current IL3	

3.7. Minimum and maximum values

Minimum and maximum values are registered with time stamps since the latest manual clearing or since the device has been restarted. The available registered min & max values are listed in the following table.

Min & Max measurement	Description
IL1, IL2, IL3	Phase current (fundamental frequency value)
IL1RMS, IL2RMS, IL3RMS	Phase current, rms value
U12, U23, U31	Line-to-line voltage
UaRMS, UbRMS, UcRMS	Line-to-neutral voltage, rms value
f	Frequency
P, Q, S	Active, reactive, apparent power
IL1da, IL2da, IL3da	Demand values of phase currents
IL11da, IL2da, IL3da (rms value)	Demand values of phase currents, rms values
Prms, Qrms, Srms	Active, reactive, apparent power, rms values
PFda	Power factor demand value

The clearing parameter "ClrMax" is common for all these values.

Parameters

Parameter	Value	Description	Set
ClrMax	_ Clear	Reset all minimum and maximum values	S

3.8. Maximum values of the last 31 days and twelve months

Some maximum and minimum values of the last 31 days and the last twelve months are stored in the non-volatile memory of the relay. Corresponding time stamps are stored for the last 31 days. The registered values are listed in the following table.

Measurement	Max	Min	Description
IL1, IL2, IL3	X		Phase current (fundamental frequency value)
S	X		Apparent power
P	X	X	Active power
Q	X	X	Reactive power

The value can be a one cycle value or an average according parameter "Timebase".

Parameters of the day and month registers

Parameter	Value	Description	Set
Timebase		Parameter to select the type of the registered values.	S
	20 ms	Collect min & max of one cycle values *)	
	200 ms	Collect min & max of 200 ms average values	
	1 s	Collect min & max of 1 s average values	
	1 min	Collect min & max of 1 minute average values	
	demand	Collect min & max of demand values (see chapter 3.6)	
ResetDays		Reset the 31 day registers	S
ResetMon		Reset the 12 month registers	S

*) This is the fundamental frequency rms value of one cycle updated every 20 ms.

3.9. Voltage measurement mode

Depending on the application and available voltage transformers, the unit can be connected either to line-to-line voltages or phase-to-ground voltages. The configuration parameter "Voltage measurement mode" must be set according the used connection.

The available modes are:

- "3LL"
  The device is connected to line-to-line voltages U_{12}, U_{23} and U_{31}. The phase-to-ground voltages are calculated. See Figure 3.9-1. The network must use only three wires. Any neutral wire must not exist.
- "3LN"
  The device is connected to phase-to-ground voltages U_{L1}, U_{L2} and U_{L3}. The zero sequence voltage is calculated. See Figure 3.9-2. There may exist a neutral wire.

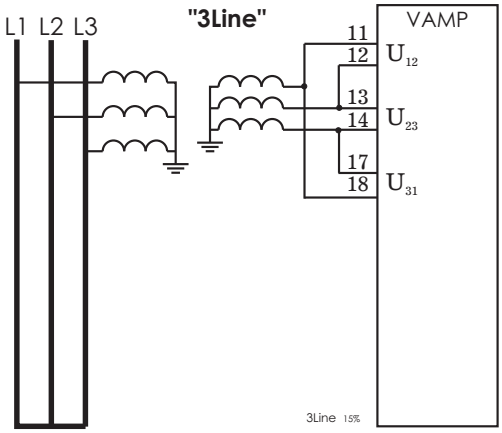


Figure 3.9-1 The device is connected to line-to-line voltages from three Y-connected voltage transformers. Voltage measurement mode is set to "3LL".

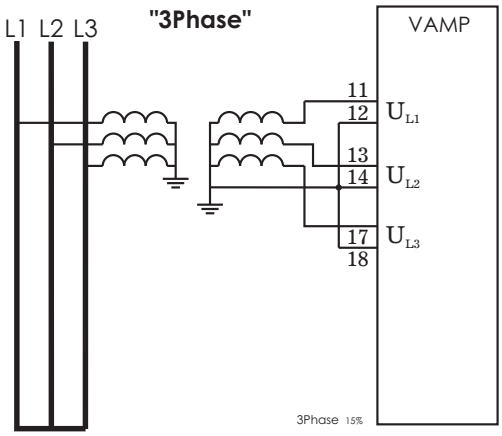


Figure 3.9-2 The device is connected to phase-to-ground voltages from three Y-connected voltage transformers. The zero sequence is calculated internally. Voltage measurement mode is set to "3LN".

3.10. Symmetric components

In a three phase system, the voltage or current phasors may be divided in symmetric components according C. L. Fortescue (1918). The symmetric components are:

- Positive sequence 1
- Negative sequence 2
- Zero sequence 0

Symmetric components are calculated according the following equations:

$$\begin{bmatrix} \underline{S}_0 \\ \underline{S}_1 \\ \underline{S}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix}\begin{bmatrix} \underline{U} \\ \underline{V} \\ \underline{W} \end{bmatrix}$$, where

$\underline{S}_0$ = zero sequence component

$\underline{S}_1$ = positive sequence component

$\underline{S}_2$ = negative sequence component

$\underline{a} = 1\angle 120° = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$, a phasor rotating constant

$\underline{U}$ = phasor of phase L1
(phase current or line-to-neutral voltage)

$\underline{V}$ = phasor of phase L2

$\underline{W}$ = phasor of phase L3

In case the voltage measurement mode is "3LL" i.e. three line-to-line voltage are measured, the following equation is used instead.

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} \underline{U}_{12} \\ \underline{U}_{23} \end{bmatrix}$$, where

U_{12} = Voltage between phases L1 and L2.

U_{23} = Voltage between phases L2 and L3.

When using line-to-line voltages, any zero sequence voltage can not be calculated. The network must use only three wires. Any neutral wire must not exist.

Example 1, single phase injection

U_N = 100 V

Voltage measurement mode is "3LL".

Injection:

U_a = U_{12} = 100 V

U_b = U_{23} = 0

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} 100\angle 0° \\ 0 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 100\angle 0° \\ 100\angle 0° \end{bmatrix} = \begin{bmatrix} 33 \\ 33 \end{bmatrix}$$

U_1 = 33 %

U_2 = 33 %

U_2/U_1 = 100 %

When using a single phase test device, the relative unbalance U_2/U_1 will always be 100 %.

Example 2, three phase injection with adjustable phase angle

U_N = 100 V

Voltage measurement mode is "3LL".

Injection:

U_a = U_{12} = 100 V $\angle 0°$

U_b = U_{23} = $100/\sqrt{3}$ V $\angle -150°$ = 57.7 V $\angle -150°$

$$\begin{bmatrix} \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & -\underline{a}^2 \\ 1 & -\underline{a} \end{bmatrix}\begin{bmatrix} 100\angle 0° \\ 100/\sqrt{3}\angle -150° \end{bmatrix} = \frac{100}{3}\begin{bmatrix} 1\angle 0° - 1/\sqrt{3}\angle +90° \\ 1\angle 0° - 1/\sqrt{3}\angle -30° \end{bmatrix} =$$

$$= \frac{100}{3}\begin{bmatrix} 2/\sqrt{3}\angle -30° \\ 1/\sqrt{3}\angle +30° \end{bmatrix} = \begin{bmatrix} 38.5\angle -30° \\ 19.2\angle +30° \end{bmatrix}$$

U_1 = 38.5 %

U_2 = 19.2 %

U_2/U_1 = 50 %

Figure 3.10-1 shows a geometric solution. The input values have been scaled with $\sqrt{3}/100$ to make the calculation easier.

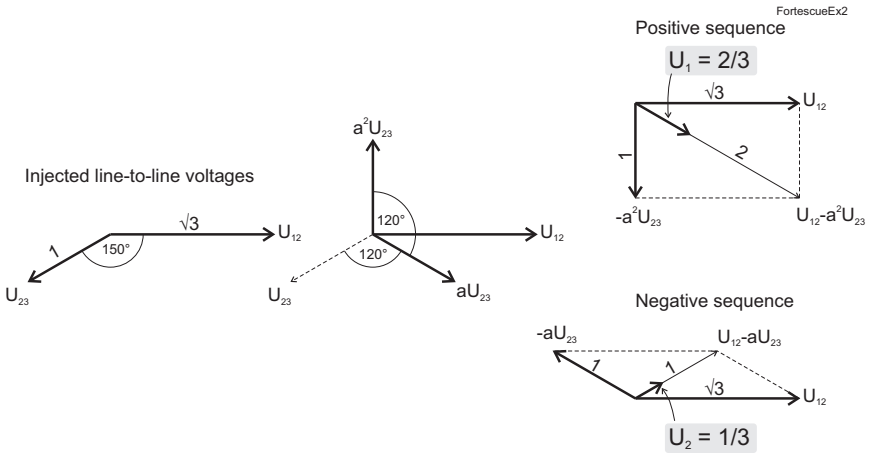


Figure 3.10-1 Example of symmetric component calculation using line-to-line voltages.

Unscaling the geometric results gives

U_1 = 100/√3 x 2/3 = 38.5 %

U_2 = 100/√3 x 1/3 = 19.2 %

U_2/U_1 = 1/3:2/3 = 50 %

Example 3, two phase injection with adjustable phase angle

U_N = 100 V

Voltage measurement mode is "3LN".

Injection:

$U_a = U_{L1} = 100/\sqrt{3}\ \text{V} \angle 0° = 57.7\ \text{V} \angle 0°$

$U_b = U_{L2} = 100/\sqrt{3}\ \text{V} \angle -120° = 57.7\ \text{V} \angle -120°$

$U_c = U_{L3} = 0\ \text{V}$

This is actually identical case with example 2 because the resulting line-to-line voltages $U_{12} = U_{L1} - U_{L2} = 100\ \text{V} \angle 30°$ and $U_{23} = U_{L2} - U_{L3} = U_{L2} = 100/\sqrt{3}\ \text{V} \angle -120°$ are the same as in example 2. The only difference is a +30° phase angle difference, but without any absolute angle reference this phase angle difference is not seen by the device.

$$\begin{bmatrix} \underline{U}_0 \\ \underline{U}_1 \\ \underline{U}_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & \underline{a} & \underline{a}^2 \\ 1 & \underline{a}^2 & \underline{a} \end{bmatrix}\begin{bmatrix} \frac{100}{\sqrt{3}}\angle 0° \\ \frac{100}{\sqrt{3}}\angle -120° \\ 0 \end{bmatrix} = \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle 0° + 100\angle -120° \\ 100\angle 0° + 100\angle 0° \\ 100\angle 0° + 100\angle +120° \end{bmatrix} =$$

$$= \frac{1}{3\sqrt{3}}\begin{bmatrix} 100\angle -60° \\ 200\angle 0° \\ 100\angle 60° \end{bmatrix} = \begin{bmatrix} 19.2\angle -60° \\ 38.5\angle 0° \\ 19.2\angle +60° \end{bmatrix}$$

U_0 = 19.2 %
U_1 = 38.5 %
U_2 = 19.2 %
U_2/U_1 = 50 %

Figure 3.10-2 shows a graphical solution. The input values have been scaled with √3/100 to make the calculation easier.

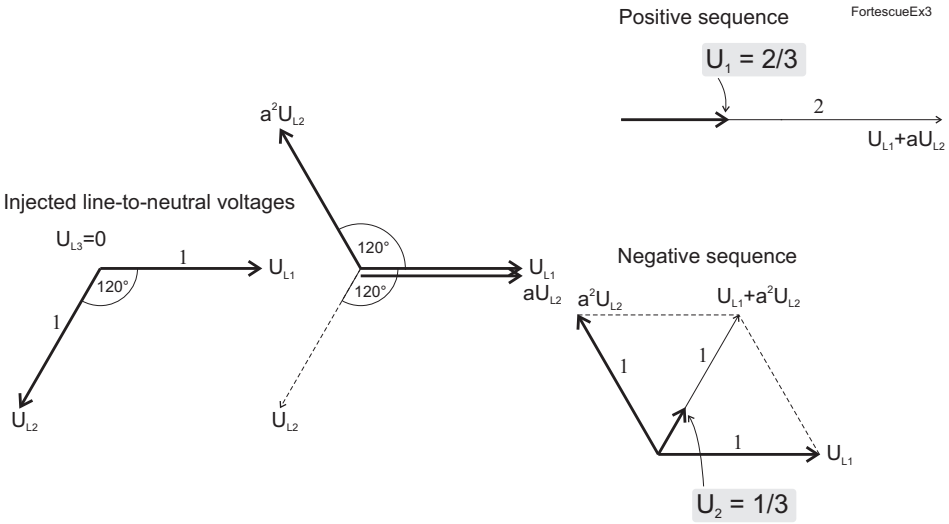


Figure 3.10-2 Example of symmetric component calculation using line-to-neutral voltages.

Unscaling the geometric results gives
U_1 = 100/√3 x 2/3 = 38.5 %
U_2 = 100√3 x 1/3 = 19.2 %
U_2/U_1 = 1/3:2/3 = 50 %

3.11. Primary and secondary scaling

Many measurement values are shown as primary values although the unit is connected to secondary signals. The scaling is done using the given CT and VT name plate values.

The following scaling equations are useful when doing secondary testing.

3.11.1. Current scaling

NOTE! The rated value of the unit's current input, 5 A or 1A, does not have any effect in the scaling equations, but it defines the measurement range and the maximum allowed continuous current. See chapter 8.1.1 for details.

Primary and secondary scaling

	Current scaling
secondary ⇒ primary	$I_{PRI} = I_{SEC} \cdot \frac{CT_{PRI}}{CT_{SEC}}$
primary ⇒ secondary	$I_{SEC} = I_{PRI} \cdot \frac{CT_{SEC}}{CT_{PRI}}$

Example 1: Secondary to primary.
CT = 500/5
Current to the unit's input is 4 A.
⇒ Primary current is I_{PRI} = 4x500/5 = 400 A

Example 2: Primary to secondary.
CT = 500/5
The relay displays I_{PRI} = 400 A
⇒ Injected current is I_{SEC} = 400x5/500 = 4 A
I_{PU} = 7/5 = 1.4 pu = 140 %

3.11.2. Voltage scaling

Primary/secondary scaling of line-to-line voltages

	Line-to-line voltage scaling	
	Voltage measurement mode = "3LL"	Voltage measurement mode = "3LN"
secondary ⇒ primary	$U_{PRI} = U_{SEC} \cdot \frac{VT_{PRI}}{VT_{SEC}}$	$U_{PRI} = \sqrt{3} \cdot U_{SEC} \cdot \frac{VT_{PRI}}{VT_{SEC}}$
primary ⇒ secondary	$U_{SEC} = U_{PRI} \cdot \frac{VT_{SEC}}{VT_{PRI}}$	$U_{SEC} = \frac{U_{PRI}}{\sqrt{3}} \cdot \frac{VT_{SEC}}{VT_{PRI}}$

Example 1: Secondary to primary. Voltage measurement mode is "3LL".

VT = 12000/110

Voltage connected to the relay's input U_a, U_b or U_c is 100 V.
⇒ Primary voltage is U_{PRI} = 100x12000/110 = 10909 V

Example 2: Secondary to primary. Voltage measurement mode is "3LN".
VT = 12000/110

Three phase symmetric voltages connected to the relay's inputs Ua, Ub and Uc are 57.7 V.
⇒ Primary voltage is U_{PRI} = √3x58x12000/110 = 10902 V

Example 3: Primary to secondary. Voltage measurement mode is "3LL".

VT = 12000/110

The relay displays U_{PRI} = 10910 V.
⇒ Secondary voltage is U_{SEC} = 10910x110/12000 = 100 V

Example 4: Primary to secondary. Voltage measurement mode is "3LN".

VT = 12000/110

The relay displays U_{12} = U_{23} = U_{31} = 10910 V.
⇒ Symmetric secondary voltages at Ua, U_b and U_c are
U_{SEC} = 10910/√3x110/12000 = 57.7 V4

3.12. Analogue outputs (option)

A terminal with the mA option has four configurable analogue outputs that take up two of the output relays (A4 and A5). Thus, a relay with the mA option has two output relays less than the version without mA option.

The resolution of the analogue output is 12 bits resulting current steps less than 6 µA. The output current range is configurable allowing e.g. the following ranges: 0 .. 20 mA and 4 .. 20 mA. More exotic ranges like 0 … 5 mA or 10 … 2 mA can be config-ured freely as long as the boundary values are within 0 … 20 mA.

Connections:

- X2: 1 AO1+ X2: 2 AO1-
- X2: 3 AO2+ X2: 4 AO2-
- X2: 5 AO3+ X2: 6 AO3-
- X2: 7 AO4+ X2: 8 AO4-

NOTE! All positive poles (X2:1, -3, -5 and -7) are internally connected together.

3.12.1. mA scaling examples

In this chapter, there are three example configurations of scaling the transducer (mA) outputs.

Example 1

Coupling	=	IL
Scaled minimum	=	0 A
Scaled maximum	=	300 A
Analogue output minimum value	=	0 mA
Analogue output maximum value	=	20 mA

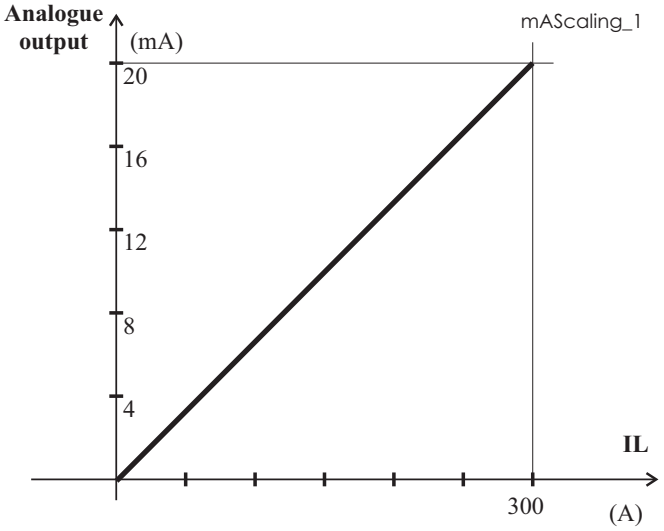


Figure 3.12.1-1. Example of mA scaling for IL, average of the three phase currents. At 0 A the transducer ouput is 0 mA, at 300 A the output is 20 mA

Example 2

Coupling	=	Uline
Scaled minimum	=	0 V
Scaled maximum	=	15000 V
Analogue output minimum value	=	4 mA
Analogue output maximum value	=	20 mA

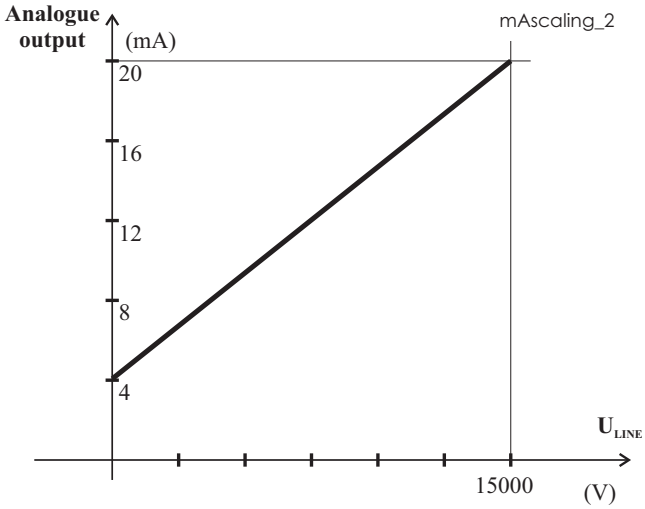


Figure 3.12.1-2. Example of mA scaling for Uline, the average of the line-to-line voltages. At 0 V the transducer ouput is 4 mA, at 15000 V the output is 20 mA

Example 3

Coupling	=	Q
Scaled minimum	=	–2000 kVar
Scaled maximum	=	6000 kVar
Analogue output minimum value	=	4 mA
Analogue output maximum value	=	20 mA

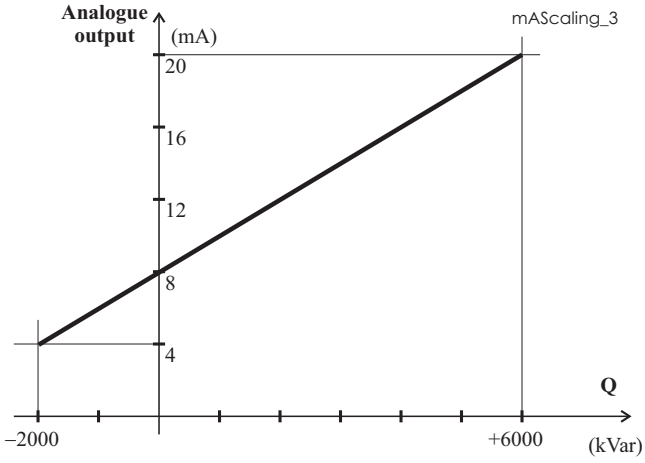


Figure 3.12.1-3. Example of mA scaling for bi-directional power. At –2000 kVar the transducer output is 4 mA, at 0 kVar it is 8 mA and at 6000 kVar the output is 20 mA

4. Control functions

4.1. Output relays

The output relays are also called digital outputs. Any internal signal can be connected to the output relays using output matrix. An output relay can be configured as latched or non-latched. See output matrix for more details.

NOTE! If the device has the mA option, it is equipped with only three alarm relays from A1 to A3.

The difference between trip contacts and alarm contacts is the DC breaking capacity. See chapters 0 and 8.1.5 for details. The contacts are SPST normal open type (NO), except alarm relays A1, A2 and A3, which have change over contacts (SPDT).

Parameters of output relays

Parameter	Value	Unit	Description	Note
T1, T2	0 1		Status of trip output relay	F
A1 ... A5	0 1		Status of alarm output relay	F
IF	0 1		Status of the internal fault indication relay	F
Force	On Off		Force flag for output relay forcing for test purposes. This is a common flag for all output relays and protection stage status, too. Any forced relay(s) and this flag are automatically reset by a 5-minute timeout.	Set
REMOTE PULSES				
A1 ... A5	0.00 ... 99.98 or 99.99	s	Pulse length for direct output relay control via communications protocols. 99.99 s = Infinite. Release by writing "0" to the direct control parameter	Set
NAMES for OUTPUT RELAYS (editable with VAMPSET only)				
Description	String of max. 32 characters		Names for DO on VAMPSET screens. Default is "Trip relay n", n=1...2 or "Alarm relay n", n=1...5	Set

Set = An editable parameter (password needed)

F = Editable when force flag is on

4.2. Digital inputs

There are six 6 digital inputs available for control purposes. The polarity – normal open (NO) / normal closed (NC – and a delay can be configured according the application. The signals are available for the output matrix, block matrix, user's programmable logic etc.

The contacts connected to digital inputs DI1 ... DI6 must be dry (potential free). These inputs use the common internal 48 V dc wetting voltage from terminal X3:1, only.

NOTE! These digital inputs must not be connected parallel with inputs of an another device.

Label and description texts can be edited with VAMPSET according the application. Labels are the short parameter names used on the local panel and descriptions are the longer names used by VAMPSET.

Parameters of digital inputs

Parameter	Value	Unit	Description	Note
DI1 ... DI6	0 1		Status of digital input	
DI COUNTERS				
DI1 ... DI6	0 ... 65535		Cumulative active edge counter	(Set)
DELAYS FOR DIGITAL INPUTS				
DI1 ... DI6	0.00 ... 60.00	s	Definite delay for both on and off transitions	Set
CONFIGURATION DI1 ... DI6				
Inverted	no yes		For normal open contacts (NO). Active edge is 0⇒1 For normal closed contacts (NC) Active edge is 1⇒0	Set
Alarm display	no yes		No pop-up display Alarm pop-up display is activated at active DI edge	Set
On event	On Off		Active edge event enabled Active edge event disabled	Set
Off event	On Off		Inactive edge event enabled Inactive edge event disabled	Set

Parameter	Value	Unit	Description	Set
NAMES for DIGITAL INPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for DIs on the local display Default is "DIn", n=1...6	Set
Description	String of max. 32 characters		Long name for DIs. Default is "Digital input n", n=1...6	Set

Set = An editable parameter (password needed)

4.3. Virtual inputs and outputs

There are four virtual inputs and six virtual outputs. The four virtual inputs acts like normal digital inputs. The state of the virtual input can be changed from display, communication bus and from VAMPSET. For example setting groups can be changed using virtual inputs.

Parameters of virtual inputs

Parameter	Value	Unit	Description	Note
VI1 ... VI4	0 1		Status of virtual input	
Events	On Off		Event enabling	Set
NAMES for VIRTUAL INPUTS (editable with VAMPSET only)				
Label	String of max. 10 characters		Short name for VIs on the local display Default is "VIn", n=1...4	Set
Description	String of max. 32 characters		Long name for VIs. Default is "Virtual input n", n=1...4	Set

Set = An editable parameter (password needed)

The six virtual outputs do act like output relays, but there are no physical contacts. Virtual outputs are shown in the output matrix and the block matrix. Virtual outputs can be used with the user's programmable logic and to change the active setting group etc.

4.4. Output matrix

By means of the output matrix, the output signals of the various protection stages, digital inputs, logic outputs and other internal signals can be connected to the output relays, front panel indicators, virtual outputs etc.

There are two LED indicators named "Alarm" and "Trip" on the front panel. Furthermore there are three general purpose LED indicators – "A", "B" and "C" – available for customer-specific indications. In addition, the triggering of the disturbance recorder (DR) and virtual outputs are configurable in the output matrix. See an example in Figure 4.4-1.

An output relay or indicator LED can be configured as latched or non-latched. A non-latched relay follows the controlling signal. A latched relay remains activated although the controlling signal releases.

There is a common "release latched" signal to release all the latched relays. This release signal resets all the latched output relays and indicators. The reset signal can be given via a digital input, via a keypad or through communication. Any digital input can be used for resetting. The selection of the input is done with the VAMPSET software under the menu "Release output matrix latches". Under the same menu, the "Release latches" parameter can be used for resetting.

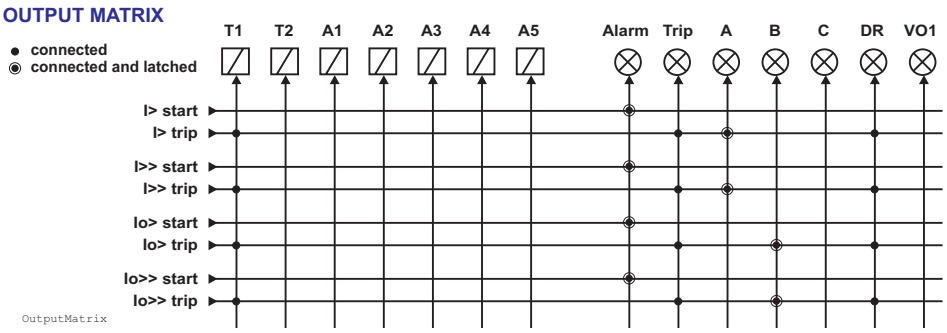


Figure 4.4-1 Output matrix.

4.5. Blocking matrix

By means of a blocking matrix, the operation of any protection stage can be blocked. The blocking signal can originate from the digital inputs DI1 to DI6, or it can be a start or trip signal from a programmable stage or an output signal from the user's programmable logic. In the block matrix Figure 4.5-1 an active blocking is indicated with a black dot (•) in the crossing point of a blocking signal and the signal to be blocked.

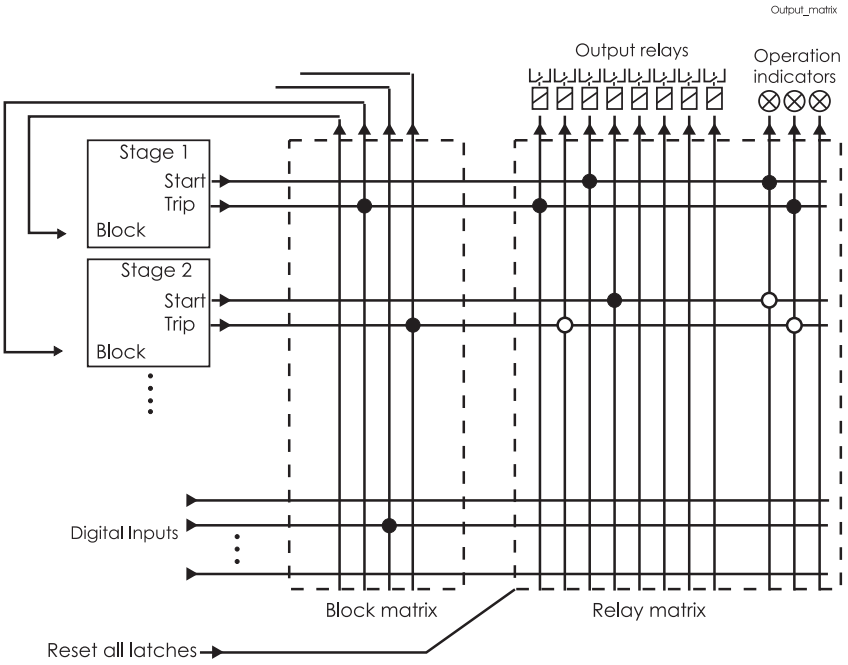


Figure 4.5-1 Blocking matrix and output matrix

4.6. Controllable objects

The unit allows controlling of six objects, that is, circuit-breakers, disconnectors and earthing switches. Controlling can be done by "select-execute" or "direct control" principle.

The logic functions can be used to configure interlocking for a safe controlling before the output pulse is issued. The objects 1...6 are controllable while the objects 7...8 are only able to show the status.

Controlling is possible by the following ways:

- through the local HMI
- through a remote communication
- through a digital input.

The connection of an object to specific output relays is done via an output matrix (object 1-6 open output, object 1-65 close output). There is also an output signal "Object failed", which is activated if the control of an object fails.

Object states

Each object has the following states:

Setting	Value	Description
Object state	Undefined (00)	Actual state of the object
	Open	
	Close	
	Undefined (11)	

Basic settings for controllable objects

Each controllable object has the following settings:

Setting	Value	Description
DI for 'obj open'	None, any digital input, virtual input or virtual output	Open information
DI for 'obj close'		Close information
DI for 'obj ready'		Ready information
Max ctrl pulse length	0.02 ... 600 s	Pulse length for open and close commands
Completion timeout	0.02 ... 600 s	Timeout of ready indication
Object control	Open/Close	Direct object control

If changing states takes longer than the time defined by "Max ctrl pulse length" setting, object fails and "Object failure" matrix signal is set. Also undefined-event is generated. "Completion timeout" is only used for the ready indication. If "DI for 'obj ready'" is not set, completion timeout has no meaning.

Output signals of controllable objects

Each controllable object has 2 control signals in matrix:

Output signal	Description
Object x Open	Open control signal for the object
Object x Close	Close control signal for the object

These signals send control pulse when an object is controlled by digital input, remote bus, etc.

Settings for read-only objects

Each read-only object has the following settings:

Setting	Value	Description
DI for 'obj open'	None, any digital input, virtual input or virtual output	Open information
DI for 'obj close'		Close information
Object timeout	0.02 … 600 s	Timeout for state changes

If changing states takes longer than the time defined by "Object timeout" setting, object fails and "Object failure" matrix signal is set. Also undefined-event is generated.

Controlling with DI (firmware version >= 5.53)

Objects can be controlled with digital input, virtual input or virtual output. There are four settings for each controllable object:

Setting	Active
DI for remote open control	In remote state
DI for remote close control	
DI for local open control	In local state
DI for local close control	

If the device is in local control state, the remote control inputs are ignored and vice versa. Object is controlled when a rising edge is detected from the selected input. Length of digital input pulse should be at least 60 ms.

4.6.1. Local/Remote selection

In Local mode, the output relays can be controlled via a local HMI, but they cannot be controlled via a remote serial communication interface.

In Remote mode, the output relays cannot be controlled via a local HMI, but they can be controlled via a remote serial communication interface.

The selection of the Local/Remote mode is done by using a local HMI, or via one selectable digital input. The digital input is normally used to change a whole station to a local or remote mode. The selection of the L/R digital input is done in the "Objects" menu of the VAMPSET software.

NOTE! A password is not required for a remote control operation.

4.7. Logic functions

The unit supports customer-defined programmable logic for boolean signals. The logic is designed by using the VAMPSET setting tool and downloaded to the relay. Functions available are:

- AND
- OR
- XOR
- NOT
- COUNTERs
- RS & D flip-flops

Maximum number of outputs is 20. Maximum number of input gates is 31. An input gate can include any number of inputs.

For detailed information, please refer to the VAMPSET manual (VMV.EN0xx).

5. Communication

5.1. Communication ports

The relay has three communication ports as standard. A fourth port, Ethernet, is available as option. See Figure 5.1-1.

There are three communication ports in the rear panel. The Ethernet port is optional. The X4 connector includes two ports: local port and extension port. The front panel RS-232 port will shut off the local port on the rear panel when a VX003 cable is inserted.

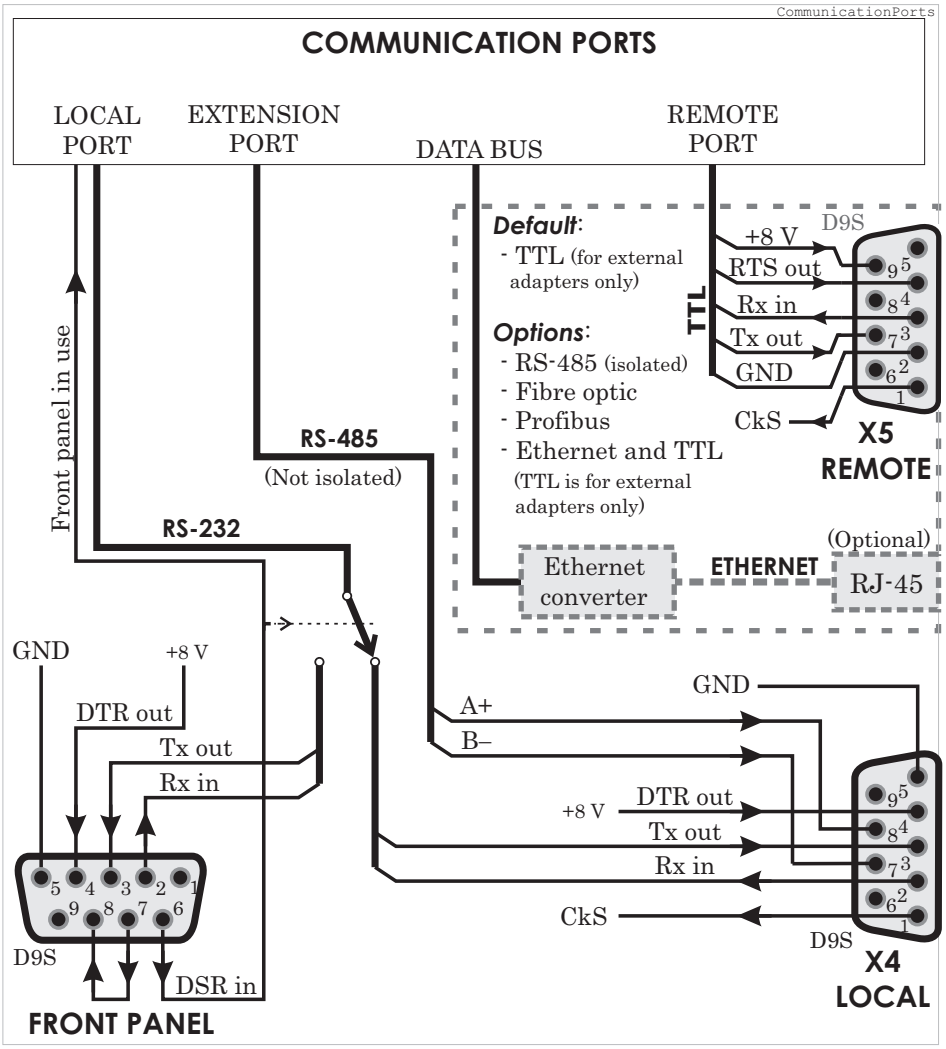


Figure 5.1-1 Communication ports and connectors. By default the X5 is a D9S type connector with TTL interface. The DSR signal from the front panel port selects the active connector for the RS232 local port.

By default the remote port has a TTL interface. It can only be used together with external converters or converting cables. Inbuilt options for RS-485, fibre optic (plastic/plastic, plastic/glass, glass/plastic or glass/glass), Profibus and Ethernet are available.

5.1.1. Local port X4

The local port has two connectors:

- On the front panel
- X4 the rear panel (D9S pins 2, 3 and 5)

Only one can be used at a time.

NOTE! The extension port is locating in the same X4 connector.

NOTE! When the VX003 cable is inserted to the front panel connector it activates the front panel port and disables the rear panel local port by connecting the DTR pin 6 and DSR pin 4 together. See Figure 5.1-1.

Protocol for the local port

The front panel port is always using the command line protocol for VAMPSET regardless of the selected protocol for the rear panel local port.

If other than "None" protocol is selected for the rear panel local port, the front panel connector, when activated, is still using the plain command line interface with the original speed, parity etc. For example if the rear panel local port is used for remote VAMPSET communication using SPA-bus default 9600/7E1, it is possible to temporarily connect a PC with VAMPSET to the front panel connector with the default 38400/8N1. While the front panel connector is in use, the rear panel local port is disabled. The communication parameter display on the local display will show the active parameter values for the local port.

Physical interface

The physical interface of this port is RS-232.

Parameters

Parameter	Value	Unit	Description	Note
Protocol	None SpaBus ProfibusDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for the rear panel local port. Command line interface for VAMPSET SPA-bus (slave) Profibus DB (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set
Msg#	0 ... 2^{32}–1		Message counter since the device has restarted or since last clearing	Clr
Errors	0 ... 2^{16}–1		Protocol errors since the device has restarted or since last clearing	Clr
Tout	0 ... 2^{16}–1		Timeout errors since the device has restarted or since last clearing	Clr
	speed/DPS Default = 38400/8N1 for VAMPSET		Display of actual communication parameters. speed = bit/s D = number of data bits P = parity: none, even, odd S = number of stop bits	1)
VAMPSET communication (Direct or SPA-bus embedded command line interface)				
Tx	bytes/size		Unsent bytes in transmitter buffer/size of the buffer	
Msg#	0 ... 2^{32}–1		Message counter since the device has restarted or since last clearing	Clr
Errors	0 ... 2^{16}–1		Errors since the device has restarted or since last clearing	Clr
Tout	0 ... 2^{16}–1		Timeout errors since the device has restarted or since last clearing	Clr

Set = An editable parameter (password needed)

Clr = Clearing to zero is possible

1) The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

5.1.2. Remote port X5

Physical interface

The physical interface of this port depends of the communication letter in the order code. See Figure 5.1-1, chapter 11 and the table below. The TTL interface is for external converters and converter cables only. It is not suitable for direct connection to distances more than one meter.

Table 5.1.2-1. Physical interface and connector types of remote port X5 with various options. TTL (A) is the default.

Order Code	Communication interface	Connector type
A	TTL (for external converters only)	D9S
B	Plastic fibre interface	HFBR-0500
C	Profibus interface	D9S
D	RS-485 (isolated)	screw crimp
E	Glass fibre interface (62.5/125 µm)	SMA
F	Plastic Rx/glass (62.5/125 µm) Tx fibre interface	HFBR-0500/SMA
G	Glass (62.5/125 µm) Rx/plastic fibre interface	SMA/HFBR-0500
H	Ethernet interface and TTL (for external converters only)	RJ-45 and D9S

Parameters

Parameter	Value	Unit	Description	Note
Protocol	None SPA-bus ProfibusDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for remote port - SPA-bus (slave) Profibus DB (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set
Msg#	0 ... 2^{32}–1		Message counter since the device has restarted or since last clearing	Clr
Errors	0 ... 2^{16}–1		Protocol errors since the device has restarted or since last clearing	Clr
Tout	0 ... 2^{16}–1		Timeout errors since the device has restarted or since last clearing	Clr

Parameter	Value	Unit	Description	Note
	speed/DPS		Display of current communication parameters. Speed = bit/s D = number of data bits P = parity: none, even, odd S = number of stop bits	1)
Debug	 No Binary ASCII		Echo to local port No echo For binary protocols For SPA-bus protocol	Set

Set = An editable parameter (password needed)

Clr = Clearing to zero is possible

1)The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

5.1.3. Extension port X4

This is a non-isolated RS-485 port for external I/O devices. The port is located in the same rear panel D9S connector X4 as the local port, but pins (7, 8, 5) are used instead of the standard RS-232 pins (2, 3, 5) used by the local port. See Figure 5.1-1.

Parameters

Parameter	Value	Unit	Description	Note
Protocol	 None SPA-bus ProfibusDP ModbusSla ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for the extension port. Command line interface for VAMPSET SPA-bus (slave) Profibus DB (slave) Modbus RTU slave Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set
Msg#	0 ... 2^{32}–1		Message counter since the device has restarted or since last clearing	Clr
Errors	0 ... 2^{16}–1		Protocol errors since the device has restarted or since last clearing	Clr
Tout	0 ... 2^{16}–1		Timeout errors since the device has restarted or since last clearing	Clr

Parameter	Value	Unit	Description	Note
	speed/DPS Default = 38400/8N1 for VAMPSET		Display of actual communication parameters. speed = bit/s D = number of data bits P = parity: none, even, odd S = number of stop bits	1)

Set = An editable parameter (password needed)

Clr = Clearing to zero is possible

1) The communication parameters are set in the protocol specific menus. For the local port command line interface the parameters are set in configuration menu.

5.1.4. Optional inbuilt ethernet port

This is an optional inbuilt Ethernet port for VAMPSET and Modbus TCP and other communication protocols using TCP/IP. See Figure 5.1-1.

The IP address, net mask, gateway, name server and NTP server are common with the internal ethernet port setting in chapter 5.2.8.

Parameters

Parameter	Value	Unit	Description	Note
Protocol	None SPA-bus ModbusTCPs IEC-103 ExternalIO DNP3		Protocol selection for the extension port. Command line interface for VAMPSET SPA-bus (slave) Modbus TCP slave IEC-60870-5-103 (slave) Modbus RTU master for external I/O-modules DNP 3.0	Set
Port	Default = 502		TCP/IP port.	Set
IpAddr	n.n.n.n		IP address. (Use VAMPSET to edit.)	Set
NetMsk	n.n.n.n		Net mask (Use VAMPSET to edit.)	Set
Gatew	n.n.n.n		Gateway (Use VAMPSET to edit.)	Set
NTPSvr	n.n.n.n		IP address for network time protocol (NTPS) server. (Use VAMPSET to edit.)	Set
VSport	Default=23		VAMPSET port for IP	Set
Msg#	0 ... 2^{32}–1		Message counter since the device has restarted or since last clearing	Clr

Parameter	Value	Unit	Description	Note
Errors	0 ... 2^{16}–1		Errors since the device has restarted or since last clearing	Clr
Tout	0 ... 2^{16}–1		Timeout errors since the device has restarted or since last clearing	Clr

Set = An editable parameter (password needed)
Clr = Clearing to zero is possible

5.2. Communication protocols

This protocols enable the transfer of the following type of data:

- events
- status information
- measurements
- control commands.
- clock synchronizing
- Settings (SPA-bus and embedded SPA-bus only)

5.2.1. PC communication

PC communication is using a VAMP specified command line interface. The VAMPSET program can communicate using the local RS-232 port or using TCP/IP and ethernet interface. It is also possible to select SPA-bus protocol for the local port and configure the VAMPSET to embed the command line interface inside SPA-bus messages. For TCP/IP configuration see chapter 5.2.8.

5.2.2. Modbus TCP and Modbus RTU

These Modbus protocols are often used in power plants and in industrial applications. The difference between these two protocols is the media. Modbus TCP uses Ethernet and Modbus RTU uses asynchronous communication (RS-485, optic fibre, RS-232).

VAMPSET will show the list of all available data items for Modbus. A separate document Modbus Parameters.pdf is also available.

The Modbus communication is activated usually for remote port via a menu selection with parameter "Protocol". See chapter 5.1.

For TCP/IP configuration see chapter 5.2.8.

Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 247		Modbus address for the device. Broadcast address 0 can be used for clock synchronizing. Modbus TCP uses also the TCP port settings.	Set
bit/s	1200 2400 4800 9600 19200	bps	Communication speed for Modbus RTU	Set
Parity	None Even Odd		Parity for Modbus RTU	Set

Set = An editable parameter (password needed)

5.2.3. Profibus DP

The Profibus DP protocol is widely used in industry. An external VPA 3CG or an internal Profibus module (see the order code in chapter 11.) is required.

Device profile "continuous mode"

In this mode the device is sending a configured set of data parameters continuously to the Profibus DP master. The benefit of this mode is the speed and easy access to the data in the Profibus master. The drawback is the maximum buffer size of 128 bytes, which limits the number of data items transferred to the master. Some PLCs have their own limitation for the Profibus buffer size, which may further limit the number of transferred data items.

Device profile "Request mode"

Using the request mode it is possible to read all the available data from the VAMP device and still use only a very short buffer for Profibus data transfer. The drawback is the slower overall speed of the data transfer and the need of increased data processing at the Profibus master as every data item must be separately requested by the master.

NOTE! In request more it is not possible to read continuously only one single data item. At least two data items must be read in turn to get updated data from the device.

There is a separate document ProfiBusDPdeviceProfilesOf-VAMPdevices.pdf available of the continuous mode and request mode.

Available data

VAMPSET will show the list of all available data items for both modes. A separate document Profibus Parameters.pdf is also available.

The Profibus DP communication is activated usually for remote port via a menu selection with parameter "Protocol". See chapter 5.1.

Parameters

Parameter	Value	Unit	Description	Note
Mode	 Cont Reqst		Profile selection Continuous mode Request mode	Set
bit/s	2400	bps	Communication speed from the main CPU to the Profibus converter. (The actual Profibus bit rate is automatically set by the Profibus master and can be up to 12 Mbit/s.)	
Emode	 Channel (Limit60) (NoLimit)		Event numbering style. Use this for new installations. (The other modes are for compatibility with old systems.)	(Set)
InBuf		bytes	Size of Profibus master's Rx buffer. (data to the master)	1) 3)
OutBuf		bytes	Size of Profibus master's Tx buffer. (data from the master)	2) 3)
Addr	1 – 247		This address has to be unique within the Profibus network system.	Set
Conv	 – VE		Converter type No converter recognized Converter type "VE" is recognized	 4)

Set = An editable parameter (password needed)

Clr = Clearing to zero is possible

1) In continuous mode the size depends of the biggest configured data offset of a data item to be send to the master. In request mode the size is 8 bytes.

2) In continuous mode the size depends of the biggest configured data offset of a data to be read from the master. In request mode the size is 8 bytes.

3) When configuring the Profibus master system, the length of these buffers are needed. The device calculates the lengths according the Profibus data and profile configuration and the values define the in/out module to be configured for the Profibus master.

4) If the value is "–", Profibus protocol has not been selected or the device has not restarted after protocol change or there is a communication problem between the main CPU and the Profibus ASIC.

5.2.4. SPA-bus

The manager has full support for the SPA-bus protocol including reading and writing the setting values. Also reading of multiple consecutive status data bits, measurement values or setting values with one message is supported.

Several simultaneous instances of this protocol, using different physical ports, are possible, but the events can be read by one single instance only.

There is a separate document Spabus Parameters.pdf of SPA-bus data items available.

Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 899		SPA-bus address. Must be unique in the system.	Set
bit/s	1200 2400 4800 9600 (default) 19200	bps	Communication speed	Set
Emode	Channel (Limit60) (NoLimit)		Event numbering style. Use this for new installations. (The other modes are for compatibility with old systems.)	(Set)

Set = An editable parameter (password needed)

5.2.5. IEC 60870-5-101

The IEC 60870-5-101 standard is derived from the IEC 60870-5 protocol standard definition. In Vamp devices, IEC 60870-5-101 communication protocol is available via menu selection. The Vamp unit works as a controlled outstation (slave) unit in unbalanced mode.

Supported application functions include process data transmission, event transmission, command transmission, general interrogation, clock synchronization, transmission of integrated totals, and acquisition of transmission delay.

For more information on IEC 60870-5-101 in Vamp devices refer to the Profile checklist document.

Parameters

Parameter	Value	Unit	Description	Note
bit/s	1200 2400 4800 9600	bps	Bitrate used for serial communication.	Set
Parity	None Even Odd		Parity used for serial communication	Set
LLAddr	1 - 65534		Link layer address	Set
LLAddrSize	1 – 2	bytes	Size of Link layer address	Set
ALAddr	1 – 65534		ASDU address	Set
ALAddrSize	1 – 2	Bytes	Size of ASDU address	Set
IOAddrSize	2 - 3	Bytes	Information object address size. (3-octet addresses are created from 2-octet addresses by adding MSB with value 0.)	Set
COTsize	1	Bytes	Cause of transmission size	
TTFormat	Short Full		The parameter determines time tag format: 3-octet time tag or 7-octet time tag.	Set
MeasFormat	Scaled Normalized		The parameter determines measurement data format: normalized value or scaled value.	Set
DbandEna	No Yes		Dead-band calculation enable flag	Set
DbandCy	100 - 10000	ms	Dead-band calculation interval	Set

Set = An editable parameter (password needed)

5.2.6. IEC 60870-5-103

The IEC standard 60870-5-103 "*Companion standard for the informative interface of protection equipment*" provides standardized communication interface to a primary system (master system).

The unbalanced transmission mode of the protocol is used, and the device functions as a secondary station (slave) in the communication. Data is transferred to the primary system using "data acquisition by polling"-principle. The IEC functionality includes the following application functions:

- station initialization
- general interrogation
- clock synchronization and
- command transmission.

It is not possible to transfer parameter data or disturbance recordings via the IEC 103 protocol interface.

The following ASDU (Application Service Data Unit) types will be used in communication from the device:

- ASDU 1: time tagged message
- ASDU 3: Measurands I
- ASDU 5: Identification message
- ASDU 6: Time synchronization and
- ASDU 8: Termination of general interrogation.

The device will accept:

- ASDU 6: Time synchronization
- ASDU 7: Initiation of general interrogation and
- ASDU 20: General command.

The data in a message frame is identified by:

- type identification
- function type and
- information number.

These are fixed for data items in the compatible range of the protocol, for example, the trip of I> function is identified by: type identification = 1, function type = 160 and information number = 90. "Private range" function types are used for such data items, which are not defined by the standard (e.g. the status of the digital inputs and the control of the objects).

The function type and information number used in private range messages is configurable. This enables flexible interfacing to different master systems.

Parameters

Parameter	Value	Unit	Description	Note
Addr	1 – 254		An unique address within the system	Set
bit/s	9600 19200	bps	Communication speed	Set
MeasInt	200 – 10000	ms	Minimum measurement response interval	Set
SyncRe	Sync Sync+Proc Msg Msg+Proc		ASDU6 response time mode	Set

Set = An editable parameter (password needed)

Parameters for disturbance record reading

Parameter	Value	Unit	Description	Note
ASDU23	On Off		Enable record info message	Set
Smpls/msg	1–25		Record samples in one message	Set
Timeout	10–10000	s	Record reading timeout	Set
Fault			Fault identifier number for IEC-103. Starts + trips of all stages.	
TagPos			Position of read pointer	
Chn			Active channel	
ChnPos			Channel read position	
Fault numbering				
Faults			Total number of faults	
GridFlts			Fault burst identifier number	
Grid			Time window to classify faults together to the same burst.	Set

Set = An editable parameter (password needed)

5.2.7. DNP 3.0

The relay supports communication using DNP 3.0 protocol.

The following DNP 3.0 data types are supported:

- binary input
- binary input change
- double-bit input
- binary output
- analog input
- counters

Additional information can be obtained from the DNP 3.0 Parameters.pdf Document.

DNP 3.0 communication is activated via menu selection. RS-485 interface is often used but also RS-232 and fibre optic interfaces are possible.

Parameters

Parameter	Value	Unit	Description	Note
bit/s	4800 9600 (default) 19200 38400	bps	Communication speed	Set
Parity	None (default) Even Odd		Parity	Set
SlvAddr	1 – 65519		An unique address for the device within the system	Set
MstrAddr	1 – 65519 255=default		Address of master	Set
LLTout	0 – 65535	ms	Link layer confirmation timeout	Set
LLRetry	1 – 255 1=default		Link layer retry count	Set
APLTout	0 – 65535 5000=default	ms	Application layer confirmation timeout	Set
CnfMode	EvOnly (default) All		Application layer confirmation mode	Set
DBISup	No (default) Yes		Double-bit input support	Set
SyncMode	0 – 65535	s	Clock synchronization request interval. 0 = only at boot	Set

Set = An editable parameter (password needed)

5.2.8. TCP/IP

Modbus TCP uses TCP/IP protocol. Also VAMPSET and SPA-bus communication can be directed via TCP/IP.

The IP address, net mask, gateway, name server and NTP server are common with the internal ethernet port setting in chapter 5.1.4.

Parameters

Parameter	Value	Unit	Description	Set
IpAddr	n.n.n.n		Internet protocol address (set with VAMPSET)	Set
NetMsk	n.n.n.n		Net mask (set with VAMPSET)	Set
Gatew	default = 0.0.0.0		Gateway IP address (set with VAMPSET)	Set
NameSv	default = 0.0.0.0		Name server (set with VAMPSET)	Set
NTPSvr	n.n.n.n		Network time protocol server (set with VAMPSET) 0.0.0.0 = no SNTP	Set
Port	502 = default		Port 502 is reserved for Modbus TCP	Set

Set = An editable parameter (password needed)

5.2.9. External I/O (Modbus RTU master)

External Modbus I/O devices can be connected to the device using this protocol. (See chapter 7.6.2 for more information).

5.2.10. IEC 61850

IEC 61850 protocol is available with the optional 61850 interface. The protocol can be configured to transfer the same information which is available with the IEC 103 protocol. Configuration is described in document "IEC 61850 communication VAMP relays/VSE 006, Configuration instructions". When IEC 61850 is used the Remote port protocol of the relay is set to IEC-103.

6. Applications

In a three-phase distribution network there are different needs for continuous measurements ranging from measurements for automation, control and supervision to energy measurements.

In the following applications several electrical quantities are typically measured for the same object:

- Power plants
  - Generator measurements
  - Measurements of power plant transmission network connection
- Industrial distribution networks
  - Transforming station infeeder measurements
  - Distribution feeder measurements
  - High-voltage motor measurements
  - Capacitor bank measurements
- Power utilities
  - Substation infeeder cubicle measurements

The above measurement needs can conveniently be fulfilled with VAMP 260, which also provides flexible connections to other systems utilizing the same measurement information:

- Serial bus connection to higher level logic systems or process automation systems
- Analogue outputs for meters or automation systems
- Contact outputs for energy pulses and alarms
- Digital inputs for collection of local position and alarm messages.

6.1. Connection example

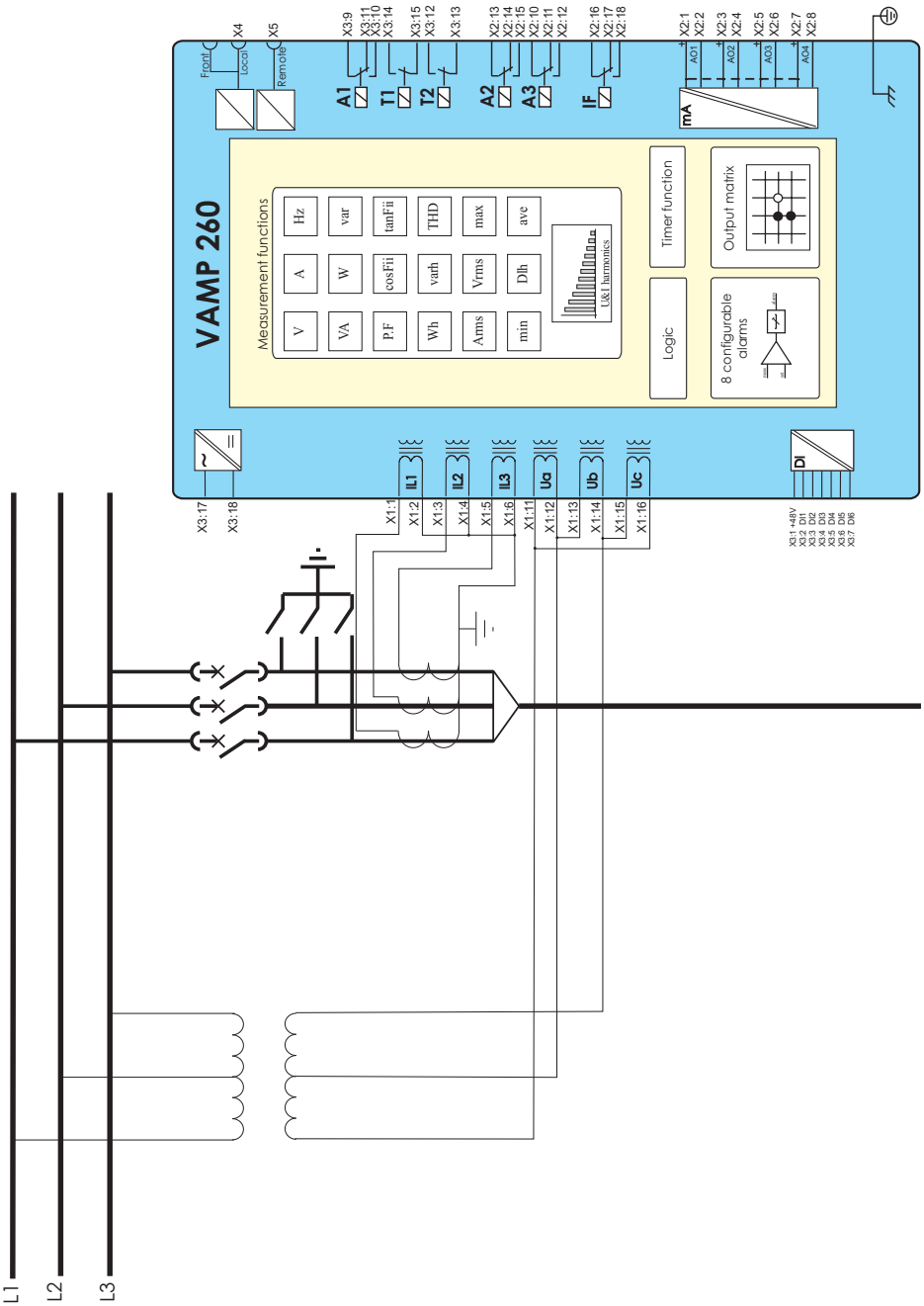


Figure 6.1-1 Connection example of power monitoring unit VAMP 260. The voltage measurement mode is set to "3LL".

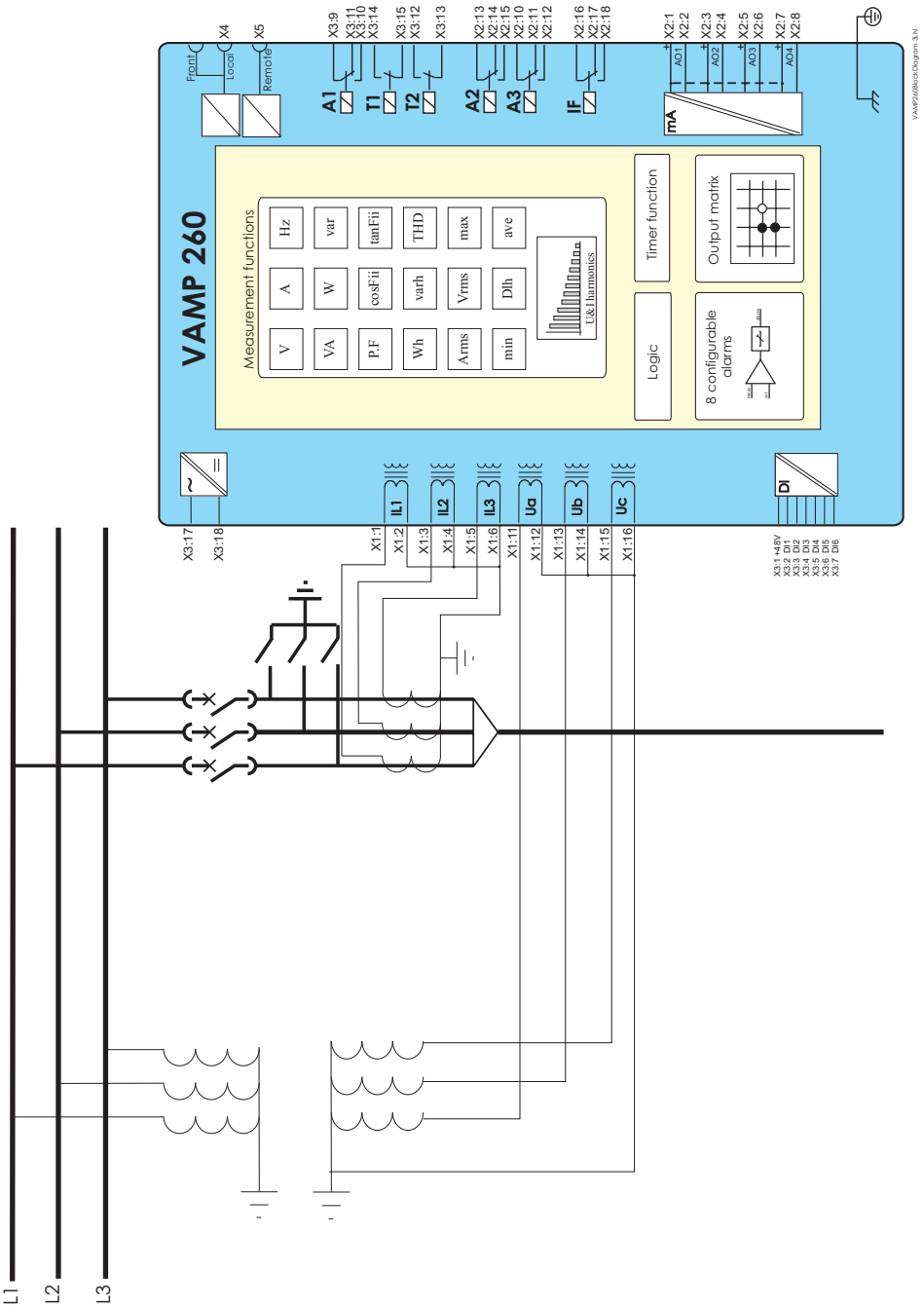


Figure 6.1-2 Connection example of power monitoring unit VAMP 260 with V-connected voltage transformers. The voltage measurement is set to "3LN".

6.2. Measurement and data acquisition system based on VAMP 260s and communication via Profibus

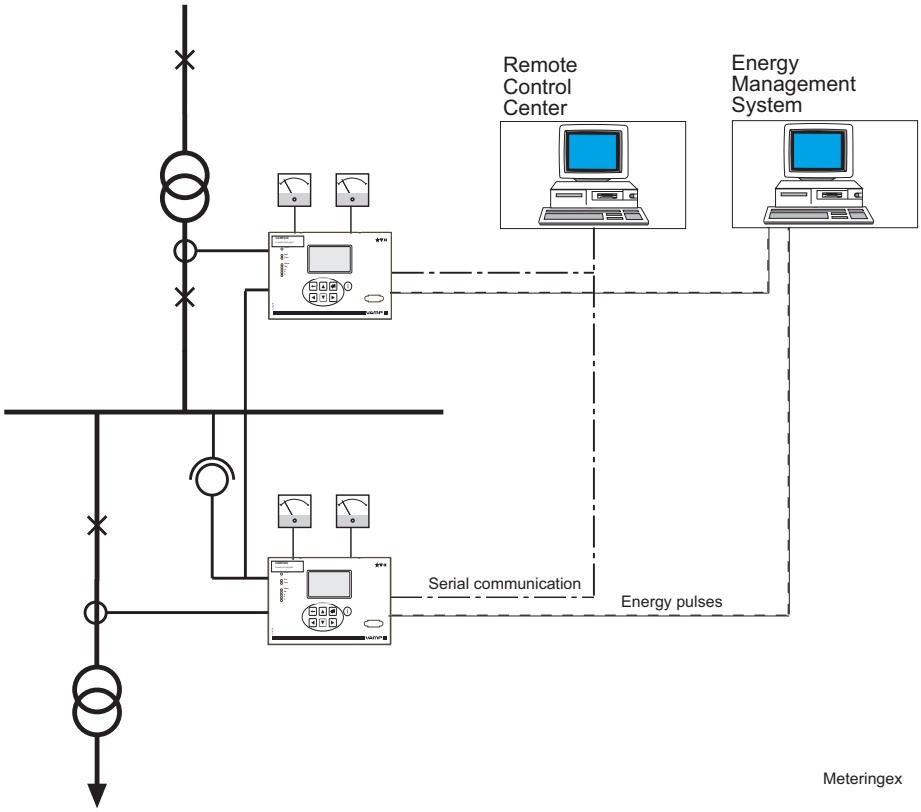


Figure 6.2-1. The measurement and data acquisition system of an industrial power network. The system is based on VAMP 260s and a PC control room, which are linked together via a serial bus. Energy pulses are available for Energy Management Systems.

6.3. Power Monitoring Unit in a 400 V network

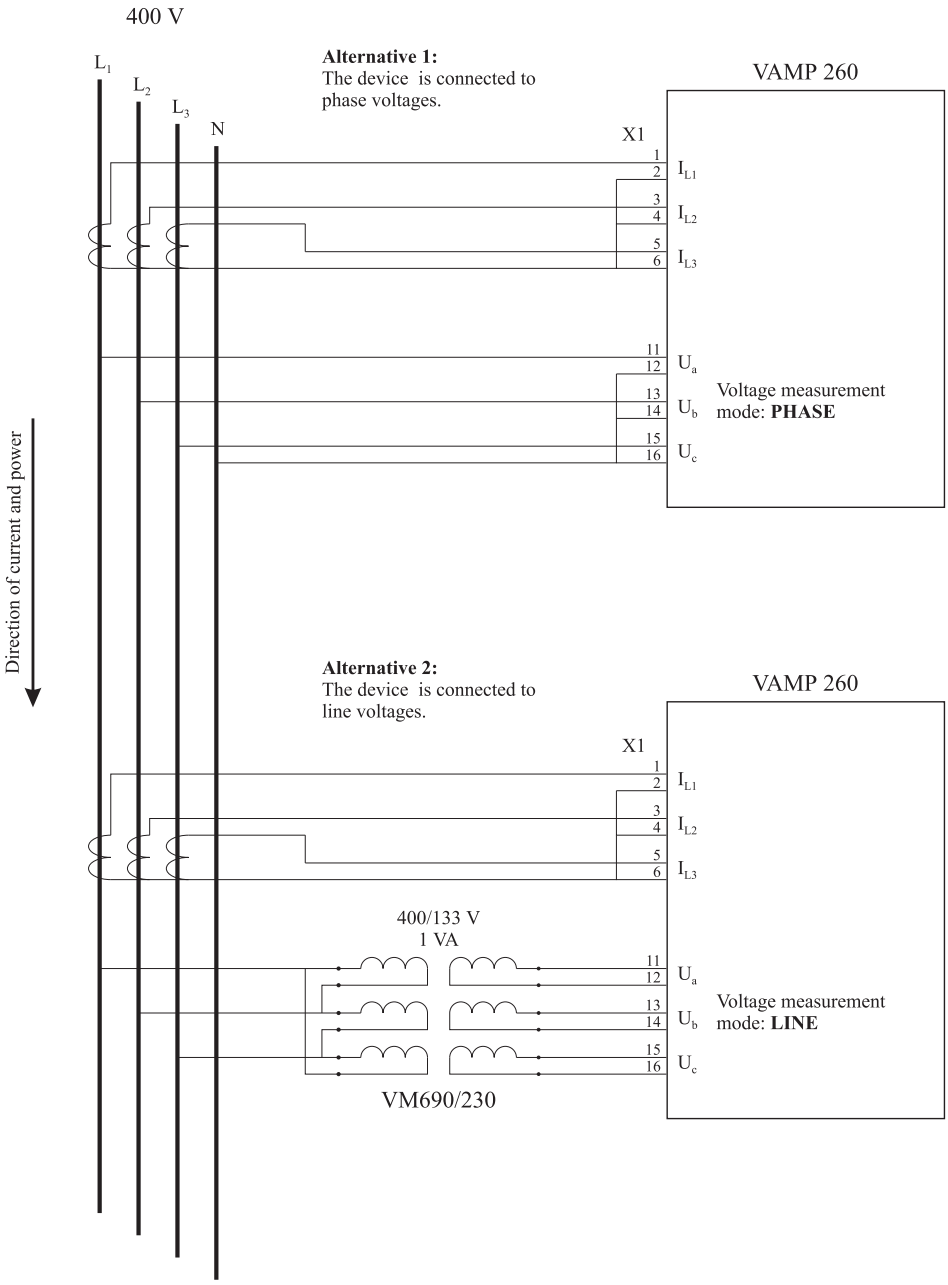


Figure 6.3-1. Example of VAMP 260 voltage measurement connection

7. Connections

7.1. Rear panel view

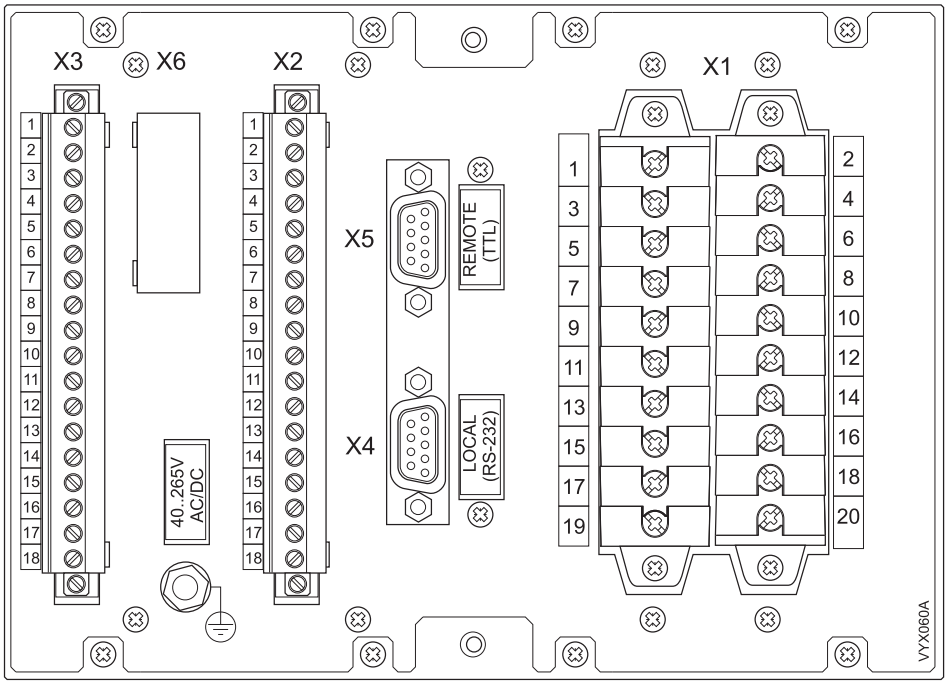
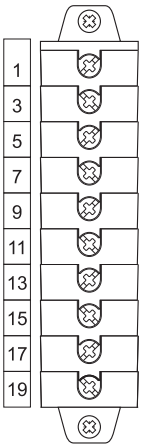


Figure 7.1-1. Connections on the rear panel of the unit.

The VAMP 260 measuring unit is connected to the protected object through the following measuring and control connections, Figure 7.1-1:

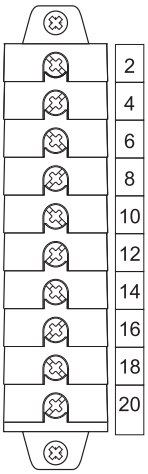
- Phase currents I_{L1}, I_{L2} and I_{L3} (terminals X1: 1-6)
- Line-to-line voltages U_{12}, U_{23} and U_{31} (terminals X1: 11-16)

Terminal X1 left side



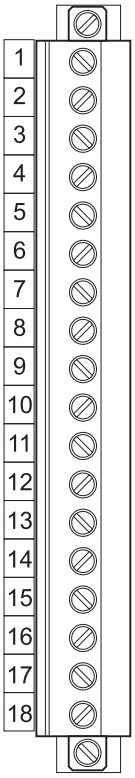
No:	Symbol	Description
1	IL1 (S1)	Phase current L1 (S1)
3	IL2 (S1)	Phase current L2 (S1)
5	IL3 (S1)	Phase current L3 (S1)
7	--	--
9	--	--
11	Ua (a)	Line-to-line voltage U12 (a) or phase-to-neutral voltage UL1 (a)
13	Ub (a)	Line-to-line voltage U23 (a) or phase-to-neutral voltage UL2 (a)
15	Uc (da,a)	Line-to-line voltage U31 (a) or phase-to-neutral voltage UL3 (a)
17	--	--
19	--	--

Terminal X1 right side



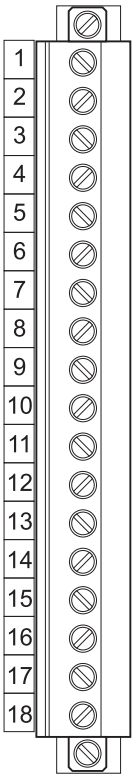
No:	Symbol	Description
2	IL1 (S2)	Phase current L1 (S2)
4	IL2 (S2)	Phase current L2 (S2)
6	IL3 (S2)	Phase current L3 (S2)
8	--	--
10	--	--
12	Ua (b,n)	Line-to-line voltage U12 (b) or phase-to-neutral voltage UL1 (n)
14	Ub (b,n)	Line-to-line voltage U23 (b) or phase-to-neutral voltage UL2 (n)
16	Uc (dn,n)	Line-to-line voltage U31 (b) or phase-to-neutral voltage UL3 (n)
18	--	--
20	--	--

Terminal X2 without the analogue output



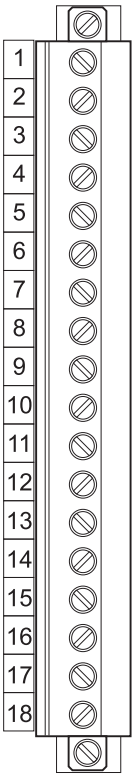
No:	Symbol	Description
1	--	--
2	--	--
3	--	--
4	--	--
5	A5	Alarm relay 5
6	A5	Alarm relay 5
7	A4	Alarm relay 4
8	A4	Alarm relay 4
9	--	--
10	A3 COM	Alarm relay 3, common connector
11	A3 NC	Alarm relay 3, normal closed connector
12	A3 NO	Alarm relay 3, normal open connector
13	A2 COM	Alarm relay 2, common connector
14	A2 NC	Alarm relay 2, normal closed connector
15	A2 NO	Alarm relay 2, normal open connector
16	IF COM	Internal fault relay, common connector
17	IF NC	Internal fault relay, normal closed connector
18	IF NO	Internal fault relay, normal open connector

Terminal X2 with the analogue output



No:	Symbol	Description
1	AO1+	Analogue output 1, common positive connector
2	AO1–	Analogue output 1, negative connector
3	AO2+	Analogue output 2, common positive connector
4	AO2–	Analogue output 2, negative connector
5	AO3+	Analogue output 3, common positive connector
6	AO3–	Analogue output 3, negative connector
7	AO4+	Analogue output 4, common positive connector
8	AO4–	Analogue output 4, negative connector
9	--	--
10	A3 COM	Alarm relay 3, common connector
11	A3 NC	Alarm relay 3, normal closed connector
12	A3 NO	Alarm relay 3, normal open connector
13	A2 COM	Alarm relay 2, common connector
14	A2 NC	Alarm relay 2, normal closed connector
15	A2 NO	Alarm relay 2, normal open connector
16	IF COM	Internal fault relay, common connector
17	IF NC	Internal fault relay, normal closed connector
18	IF NO	Internal fault relay, normal open connector

Terminal X3



No:	Symbol	Description
1	+48V	Internal wetting voltage for digital inputs 1 – 6
2	DI1	Digital input 1
3	DI2	Digital input 2
4	DI3	Digital input 3
5	DI4	Digital input 4
6	DI5	Digital input 5
7	DI6	Digital input 6
8	--	--
9	A1 COM	Alarm relay 1, common connector
10	A1 NO	Alarm relay 1, normal open connector
11	A1 NC	Alarm relay 1, normal closed connector
12	T2	Trip relay 2
13	T2	Trip relay 2
14	T1	Trip relay 1
15	T1	Trip relay 1
16	--	--
17	Uaux	Auxiliary voltage
18	Uaux	Auxiliary voltage

7.2. Digital inputs

The digital inputs use the internal 48 V dc auxiliary voltage of the unit (terminal X3: 1). Potential-free contacts must be available in the protected object for transfer of status information to the unit.

7.3. Auxiliary voltage

The external auxiliary voltage U_{AUX} (standard 40…260 V ac or dc) for the unit is connected to the terminals X3: 17-18.

NOTE! Polarity of the auxiliary voltage U_{AUX} (24 V dc, option B) : - = X3:17 and + = X3:18.

7.4. Output relays

The power-monitoring unit is equipped with seven (five) configurable output relays and a separate output relay for the self-supervision system.

- Trip relays T1 and T2 (terminals X3: 14-15 and 12-13)
- Alarm relays A1 - A5 (terminals X2: 9-11, X2: 13-15, 10-12, 7-8, 5-6)
    - In the mA version of the PMU the alarm relays A4 (X2:7-8) and A5 (X2:5-6) are excluded.
- Self-supervision system output relay IF (terminals X2: 16-18)

7.5. Serial communication connection

The pin assignments of communication connectors including internal communication converters are presented in the following figures and tables.

7.5.1. Front panel connector

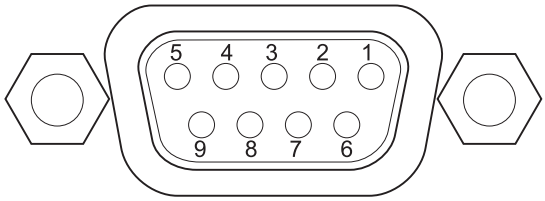


Figure 7.5.1-1 Pin numbering of the front panel D9S connector

Pin	RS232 signal
1	Not connected
2	Rx in
3	Tx out
4	DTR out (+8 V)
5	GND
6	DSR in (activates this port and disables the X4 RS232 port)
7	RTS in (Internally connected to pin 8)
8	CTS out (Internally connected to pin 7)
9	No connected

NOTE! DSR must be connected to DTR to activate the front panel connector and disable the rear panel X4 RS232 port. (The other port in the same X4 connector will not be disabled.)

7.5.2. Rear panel connector X5 (REMOTE)

The X5 remote port communication connector options are shown in Figure 7.5.2-1, Figure 7.5.2-2, Figure 7.5.2-3, and Figure 7.5.2-4. The connector types are listed in Table 5.1.2-1.

Without any internal options, X5 is a TTL port for external converters. Some external converters (VSE) are attached directly to the rear panel and X5. Some other types (VEA, VPA) need various TTL/RS-232 converter cables. The available accessories are listed in chapter 11.

Internal options for 2&4-wire galvanically isolated RS-485 (Figure 7.5.2-2), fibre optic (Figure 7.5.2-3), and Profibus (Figure 7.5.2-4) are available. See ordering code in chapter 11.

Port (Remote)	Pin/ Terminal	TTL (Default)	RS-485 (Option)	Profibus DP (Option)
X5	1	reserved	Signal Ground	
X5	2	Tx out /TTL	Receiver –	
X5	3	Rx in /TTL	Receiver +	RxD/TxD +/P
X5	4	RTS out /TTL	Transmitter –	RTS
X5	5		Transmitter +	GND
X5	6			+5V
X5	7	GND		
X5	8			RxD/TxD -/N
X5	9	+8V out		

NOTE! In the VAMP relays RS485 interfaces a positive voltage from Tx+ to Tx– or Rx+ to Rx– does correspond to the bit value "1". In X5 connector the optional RS485 is galvanically isolated.

NOTE! In 2-wire mode the receiver and transmitter are internally connected in parallel. See a table below.

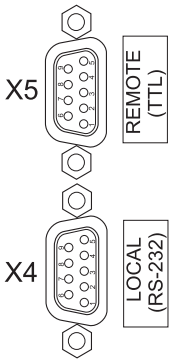


Figure 7.5.2-1 Pin numbering of the rear communication ports, REMOTE TTL

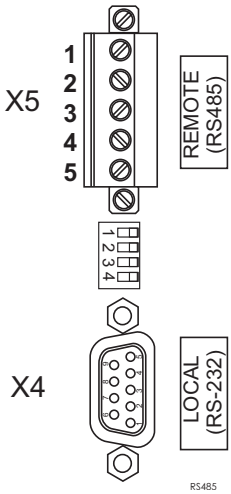


Figure 7.5.2-2 Pin numbering of the rear communication ports, REMOTE RS-485.

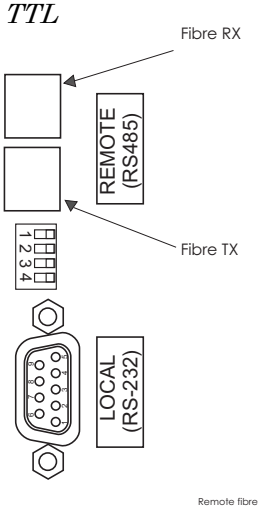


Figure 7.5.2-3 Picture of rear communication port, REMOTE FIBRE.

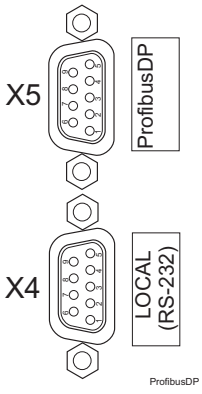


Figure 7.5.2-4 Pin numbering of the rear communication ports, Profibus DP.

7.5.3. X4 rear panel connector (local RS232 and extension RS485 ports)

Rear panel port (LOCAL)	Pin	Signal
X4	1	No connection
X4	2	Rx in, RS232 local
X4	3	Tx out, RS232 local
X4	4	DTR out (+8 V)
X4	5	GND
X4	6	No connection
X4	7	B– RS485 extension port
X4	8	A+ RS485 extension port
X4	9	No connection

NOTE! In the VAMP relays a positive RS485 voltage from A+ to B– corresponds to bit value "1". In X4 connector the RS485 extension port is not galvanically isolated.

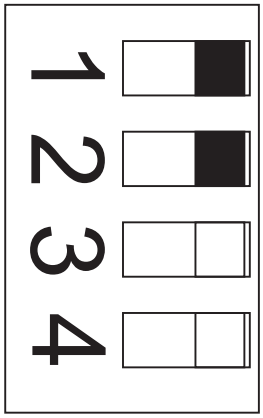


Figure 7.5.3-1 Dip switches in RS-485 and optic fibre options.

Dip switch number	Switch position	Function RS-485	Function Fibre optics
1	Left	2 wire connection	Echo off
1	Right	4 wire connection	Echo on
2	Left	2 wire connection	Light on in idle state
2	Right	4 wire connection	Light off in idle state
3	Left	Termination On	Not applicable
3	Right	Termination Off	Not applicable
4	Left	Termination On	Not applicable
4	Right	Termination Off	Not applicable

NOTE! The internal 2-wire RS485 port in X4 connector is not galvanically isolated.

7.6. External I/O extension modules

7.6.1. External LED module VAM 16D

The optional external VAM 16D led module provides 16 extra led-indicators in external casing. Module is connected to the serial port of the device's front panel. Please refer the User manual VAM 16 D, VM16D.ENxxx for details.

7.6.2. External input / output module

The device supports an optional external input/output modules sed to extend the number of digital inputs and outputs. Also modules for analogue inputs and outputs are available. The following types of devices are supported:

- Analog input modules (RTD)
- Analog output modules (mA-output)
- Binary input/output modules

EXTENSION port is primarily designed for IO modules. This port is found in the LOCAL connector of the device backplane and IO devices should be connected to the port with VSE003 adapter.

NOTE! If ExternalIO protocol is not selected to any communication port, VAMPSET doesn't display the menus required for configuring the IO devices. After changing EXTENSION port protocol to ExternalIO, restart the device and read all settings with VAMPSET.

External analog inputs configuration (VAMPSET only)

EXTERNAL ANALOG INPUTS

AI Enabled	AI Meas	AI Unit	AI Slave Address	AI ModBus Address	AI Register Type	AI Offset	x1	y1	x2	y2	AI Error Counter
On	0.00 C	C	1	1	HoldingR	0	0	0	1	1	0
Off	0.00 C	C	1	2	HoldingR	0	0	0	1	1	0
Off	0.00 C	C	1	3	HoldingR	0	0	0	1	1	0

Range	On / Off		C, F, K, or V/A	1…247	1…9999	InputR or HoldingR	-32000…32000	X: -32000…32000 Y: -1000…1000	
Description	Enabling for measurement	Active value	Unit selection	Modbus address of the IO device	Modbus register for the measurement	Modbus register type	**Scaling:**		Communication read errors

Scaling:

X1	Modbus value	Point 1
Y1	Scaled value	
X2	Modbus value	Point 2
Y2	Scaled value	
offset	Subtracted from Modbus value, before running XY scaling	

Alarms for external analog inputs

EXTERNAL ANALOG INPUT ALARMS

AI Enabled	AI Slave Address	AI ModBus Address	AI Meas	External AI Alarm State >	Alarm Limit >	External AI Alarm State >>	Alarm Limit >>	Alarm Hysteresis
On	1	1	0.00 C	-	0.0	-	0.0	1.0
Off	1	2	0.00 C	-	0.0	-	0.0	1.0
Off	1	3	0.00 C	-	0.0	-	0.0	1.0

Range	On / Off	1…247	1…9999		- / Alarm	-21x107… …21x107	- / Alarm	-21x107… …21x107	0…10000
Description	Enabling for measurement	Modbus address of the IO device	Modbus register for the measurement	Active value	**Alarm >**		**Alarm >>**		Hysteresis for alarm limits
					Active state	Limit setting	Active state	Limit setting	

Analog input alarms have also matrix signals, “Ext. AIx Alarm1” and “Ext. AIx Alarm2”.

External digital inputs configuration (VAMPSET only)

EXTERNAL DIGITAL INPUTS

DI Enabled	DI State	DI Slave Address	DI ModBus Address	DI Register Type	DI Selected Bit	DI Error Counter
On	0	1	1	CoilS	1	0
Off	0	1	2	CoilS	1	0
Off	0	1	3	CoilS	1	0

Range	On / Off	0 / 1	1...247	1...9999	CoilS, InputS, InputR or HoldingR	1...16	
Description	Enabling for input	Active state	Modbus address of the IO device	Modbus register for the measurement	Modbus register type	Bit number of Modbus register value	Communication read errors

External digital outputs configuration (VAMPSET only)

EXTERNAL DIGITAL OUTPUTS

DO Enabled	DO State	DO Slave Address	DO ModBus Address	DO Error Counter
On	0	1	1	0
Off	0	1	2	0
Off	0	1	3	0

Range	On / Off	0 / 1	1...247	1...9999	
Description	Enabling for output	Output state	Modbus address of the IO device	Modbus register for the measurement	Communication errors

External analog outputs configuration (VAMPSET only)

EXTERNAL ANALOG OUTPUTS

AO Enabled	mA Output	mA Min	mA Max	AO Link	Linked Val. Min	Linked Val. Max	AO Slave Address	AO ModBus Address	AO Register Type	ModBus Min	ModBus Max	AO Error Counter
On	0.00	0	20	IL1	0 A	1000 A	1	1	HoldingR	0	100	0
Off	0.00	0	20	IL2	0 A	1000 A	1	2	HoldingR	0	100	0
Off	0.00	0	20	IL3	0 A	1000 A	1	3	HoldingR	0	100	0

Description	Range
Enabling for measurement	On / Off
Active value	
Minimum & maximum output values	-21x107… …+21x107
Link selection	
Minimum limit for lined value, corresponding to "Modbus Min"	0…42x108, -21…+21x108
Maximum limit for lined value, corresponding to "Modbus Max"	
Modbus address of the IO device	1…247
Modbus register for the output	1…9999
Modbus register type	InputR or HoldingR
Modbus value corresponding Linked Val. Min	-32768…+32767 (0…65535)
Modbus value corresponding Linked Val. Max	
Communication errors	

7.7. Block diagram

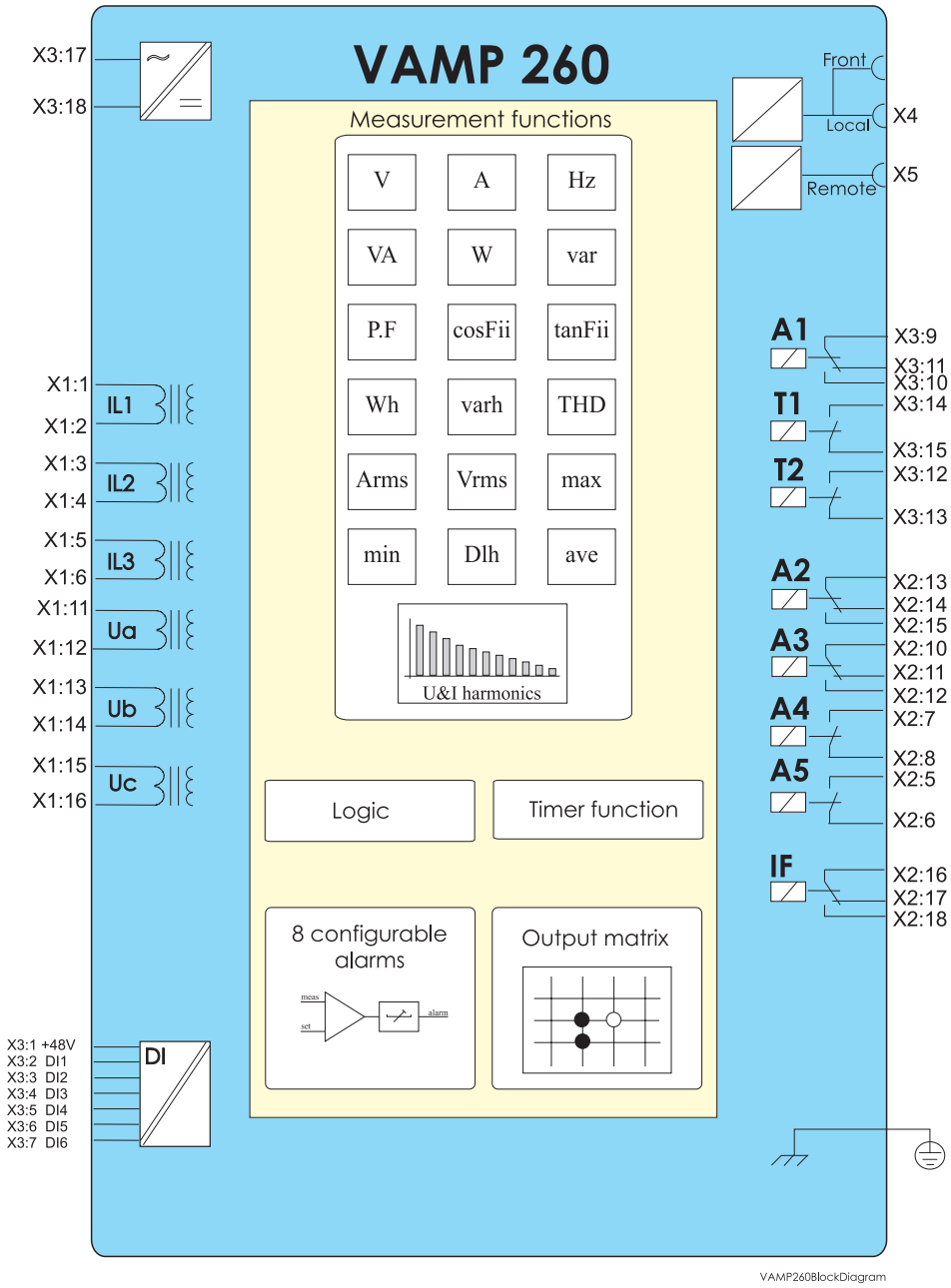


Figure 7.7-1 Block diagram of the power monitoring unit VAMP 260.

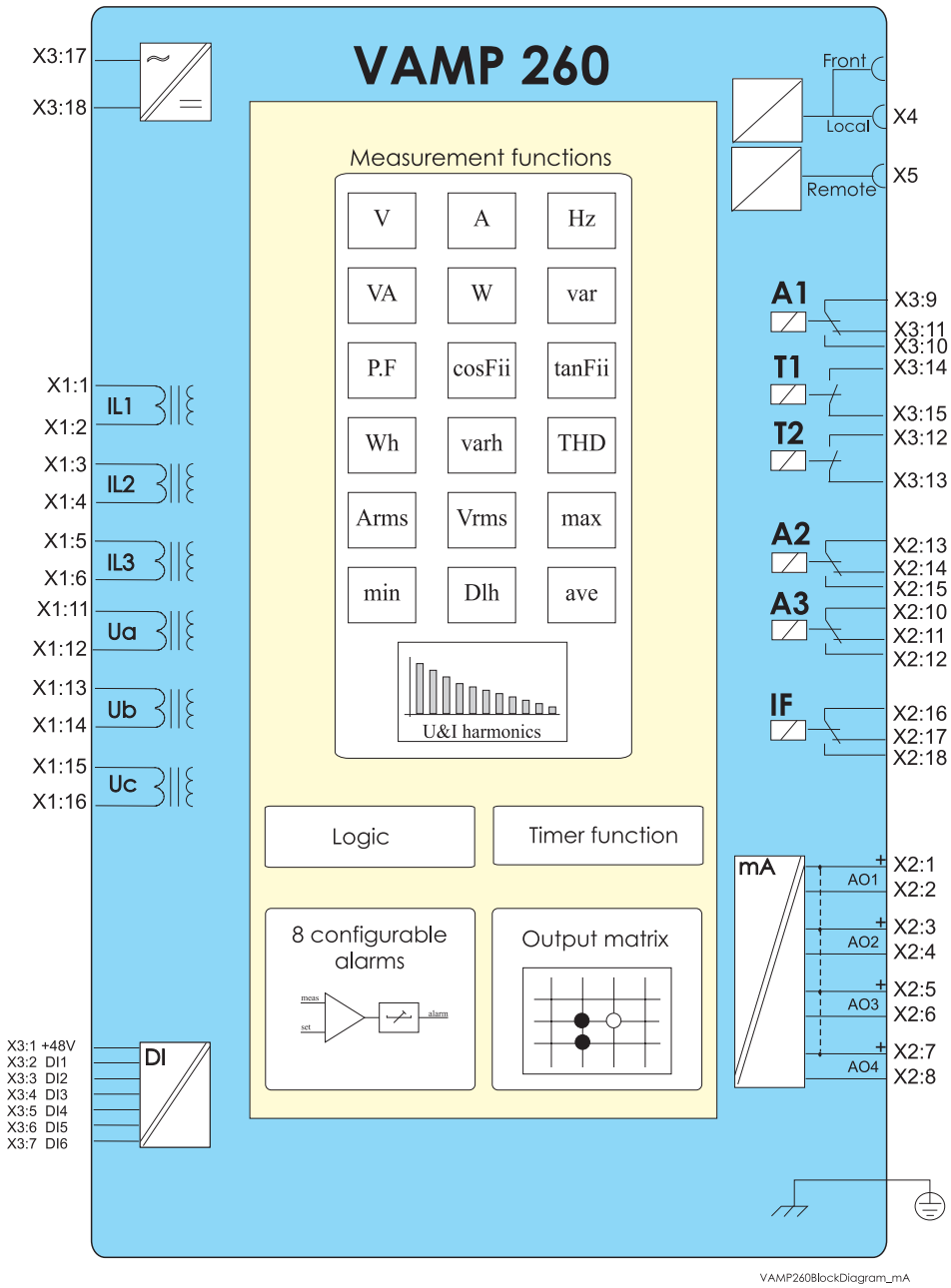


Figure 7.7-2 Block diagram of the power monitoring unit VAMP 260, with mA-option.

8. Technical data

8.1. Connections

8.1.1. Measuring circuitry

Rated current I_n - Current measuring range - Thermal withstand - Burden	1 A or 5 A 0 - 5 x I_n 4 x I_n (continuously) 20 x I_n (for 10 s) 100 x I_n (for 1 s) < 0.1 VA (In = 1 A) < 0.2 VA (In = 5 A)
Rated voltage U_n - Voltage measuring range - Continuous voltage withstand - Burden	50 - 240 V (configurable) 0 – 260 V 275 V < 0.5V A
Rated frequency f_n - Frequency measuring range	45 - 65 Hz 16 - 75 Hz
Terminal Block: - Solid or stranded wire	Max. wire dimension: 4 mm² (10-12 AWG)

8.1.2. Auxiliary voltage

	Type A (standard)	**Type B (option)**
Rated voltage U_{aux}	40 - 265 V ac/dc 110/120/220/240 V ac 48/60/110/125/220 V dc	18 - 36 V dc 24 V dc
Power consumption Max. permitted interruption time	< 7 W (normal conditions) < 15 W (output relays activated) < 50 ms (110 V dc)	
Terminal Block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm² (13-14 AWG)	

8.1.3. Digital inputs

Number of inputs	6
Operation time	0.00 – 60.00 s (step 0.01 s)
Polarity	NO (normal open) or NC (normal closed)
Inaccuracy: - Operate time	 ±1% or ±10 ms
Internal operating voltage	48 V dc
Current drain when active (max.)	Approx. 20 mA
Current drain, average value	< 1 mA
Terminal block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm² (13-14 AWG)

8.1.4. Trip contacts

Number of contacts	2 making contacts
Rated voltage	250 V ac/dc
Continuous carry	5 A
Max. making current	15 A
Breaking capacity, AC	2 000 VA
Breaking capacity, DC (L/R=40ms)	50 W
Contact material	AgNi 90/10
Terminal Block: - Phoenix MVSTBW or equivalent	Max. wire dimension: 2.5 mm² (13-14 AWG)

8.1.5. Alarm contacts

Number of contacts:	3 change-over contacts (relays A1, A2 and A3) 2 making contacts (relays A4 and A5) (Not available with the mA option) 1 change-over contact (IF relay)
Rated voltage	250 V ac/dc
Continuous carry	5 A
Breaking capacity, AC	2 000 VA
Contact material	AgNi 0.15 gold plated
Terminal block - Phoenix MVSTBW or equivalent	Maximum wire dimension 2.5 mm² (13-14 AWG)

8.1.6. Local serial communication port

Number of ports	1 on front and 1 on rear panel
Electrical connection	RS 232
Data transfer rate	1 200 - 38 400 kb/s

8.1.7. Remote control connection

Number of ports	1 on rear panel
Electrical connection	TTL (standard) RS 485 (option) RS 232 (option) Plastic fiber connection (option)
Data transfer rate	1 200 - 38 400 kb/s
Protocols	ModBus,, RTU master ModBus,, RTU slave SpaBus, slave IEC 61850 IEC-60870-5-101 IEC-60870-5-103 Profibus DP (option) ModBus TCP (option, external module)

8.1.8. Analogue output connections (option)

Number of analogue mA output channels	4
Maximum output current	1 - 20 mA, step 1 mA
Minimum output current	0 - 19 mA, step 1 mA
Exception output current	0 - 20.50 mA, step 10 µA
Resolution	12 bits
Current step	< 6 µA
Inaccuracy	±20 µA

8.2. Tests and environmental conditions

8.2.1. Disturbance tests (EN 50263)

Emission	
- Conducted (EN 55022) - Emitted (EN 55022)	0.15 - 30 MHz 30 - 1 000 MHz
Immunity	
- Static discharge (ESD)	EN 61000-4-2, class III 6 kV contact discharge 8 kV air discharge
- Fast transients (EFT)	EN 61000-4-4, class III 2 kV, 5/50 ns, 5 kHz, +/-
- Surge	EN 61000-4-5, class III 1 kV, 1.2/50 µs, common mode 2 kV, 1.2/50 µs, differential mode
- Conducted RF field	EN 61000-4-6 0.15 - 80 MHz, 10 V/m, 80% AM (1 kHz)
- Emitted RF field	EN 61000-4-3 80 - 1000 MHz, 10 V/m, 80% AM (1 kHz)
- GSM test	EN 61000-4-3 900 MHz, 10 V/m, pulse modulated
1 MHz burst	IEC 60255-22-1 1 kV, differential mode 2,5 kV, common mode
Voltage interruption	IEC 60255-11

8.2.2. Test voltages

Insulation test voltage (IEC 60255-5)	2 kV, 50 Hz, 1 min
Surge voltage (IEC 60255-5)	5 kV, 1.2/50 µs, 0.5 J

8.2.3. Mechanical tests

Vibration (IEC 60255-21-1)	10...60 Hz, amplitude ±0.035 mm 60...150 Hz, acceleration 0.5g Sweep rate 1 octave/min 20 periods in X-, Y- and Z axis direction
Shock (IEC 60255-21-1)	Half sine, acceleration 5 g, duration 11 ms 3 shocks in X-, Y- and Z axis direction

8.2.4. Environmental conditions

Operating temperature	0 to +55 °C
Transport and storage temperature	-40 to +70 °C
Relative humidity	< 75% (1 year, average value) < 90% (30 days per year, no condensation permitted)

8.2.5. Casing

Degree of protection (IEC 60529)	IP20
Dimensions (W x H x D)	208 x 155 x 225 mm
Material	1 mm steel plate
Weight	4.2 kg
Color code	RAL 7032 (Casing) / RAL 7035 (Back plate)

8.2.6. Package

Dimensions (W x H x D)	215 * 160 * 275 mm
Weight (Relay, Package and Manual)	5.2 kg

8.3. Main functions

8.3.1. Disturbance recorder (DR)

The operation of disturbance recorder depends on the following settings. The recording time and the number of records depend on the time setting and the number of selected channels.

Disturbance recorder (DR)

Mode of recording:	Saturated / Overflow
Sample rate:	
- Waveform recording	32/cycle, 16/cycle, 8/cycle
- Trend curve recording	10, 20, 200 ms 1, 5, 10, 15, 30 s 1 min
Recording time (one record)	0.1 s – 12 000 min (must be shorter than MAX time)
Pre-trigger rate	0 – 100%
Number of selected channels	0 – 12

8.3.2. Voltage sag & swell

Voltage sag limit	10 – 120 %
Voltage swell limit	20 – 150 %
Definite time function: - Operating time	DT 0.08 – 1.00 s (step 0.02 s)
Low voltage blocking Reset time Reset ration: - Sag - Swell Block limit	0 – 50 % <60 ms 1.03 0.97 0.5 V or 1.03 (3 %)
Inaccuracy: - Activation - Activation (block limit) - Operating time at definite time function	 ±0.5 V or 3% of the set value ±5% of the set value ±1% or ±30 ms

If one of the phase voltages is below sag limit and above block limit but another phase voltage drops below block limit, blocking is disabled.

8.3.3. Voltage interruptions

Voltage low limit (U1)	10 – 120 %
Definite time function: - Operating time	DT <50 ms (Fixed)
Reset time Reset ratio:	<60 ms 1.03
Inaccuracy: - Activation	 3% of the set value

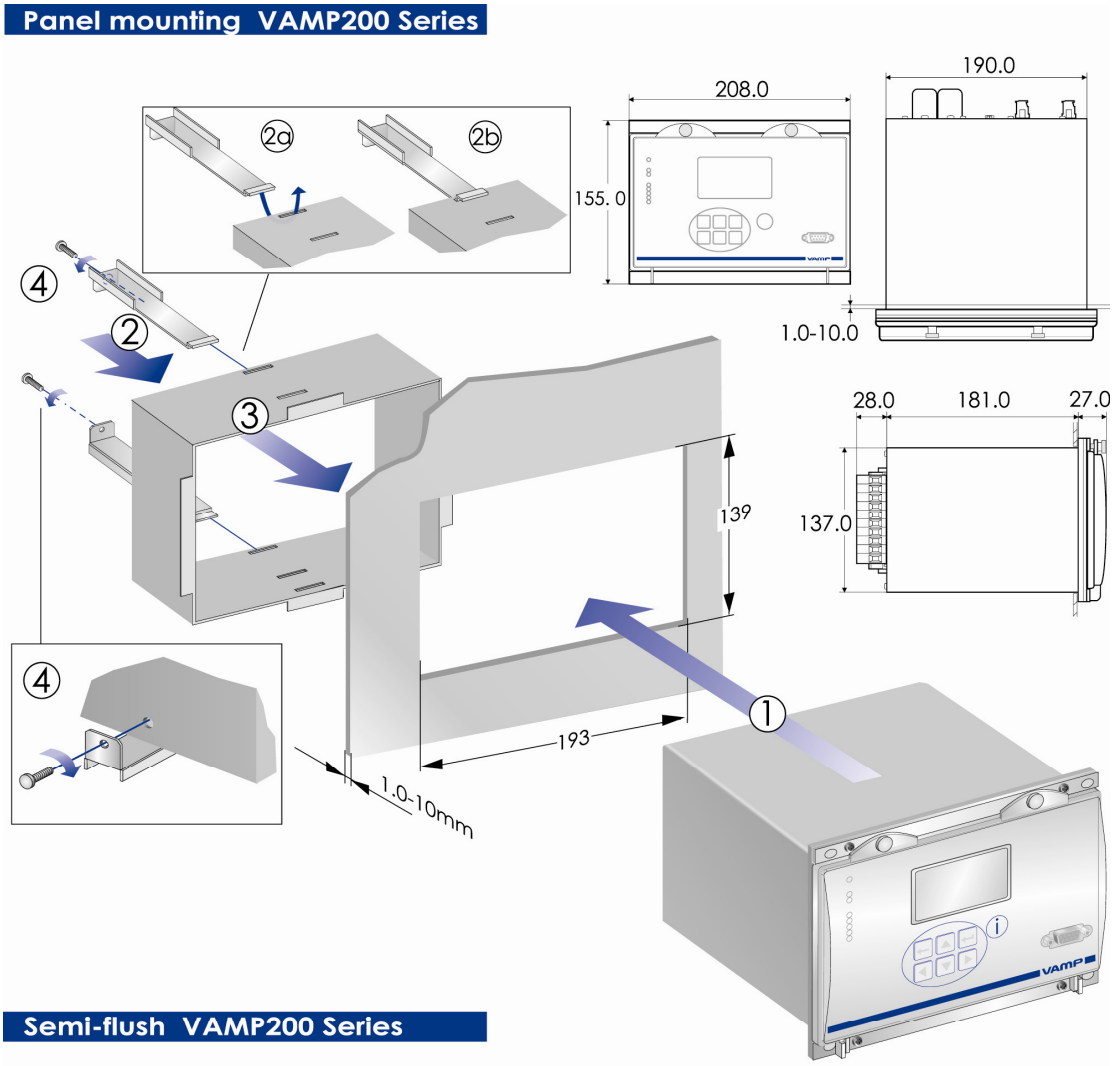
9. Abbreviations and symbols

ANSI	American National Standards Institute. A standardization organisation.
cosφ	Active power divided by apparent power = P/S. (See power factor PF). Negative sign indicates reverse power.
CT	Current transformer
DI	Digital input
DO	Digital output, output relay
DSR	Data set ready. An RS232 signal. Input in front panel port of VAMP relays to disable rear panel local port.
DST	Daylight saving time. Adjusting the official local time forward by one hour for summer time.
DTR	Data terminal ready. An RS232 signal. Output and always true (+8 Vdc) in front panel port of VAMP relays.
FFT	Fast Fourier transform. Algorithm to convert time domain signals to frequency domain or to phasors.
I_N	Nominal current. Rating of CT primary or secondary.
IEC	International Electrotechnical Commission. An international standardization organisation.
IEEE	Institute of Electrical and Electronics Engineers
IEC-103	Abbreviation for communication protocol defined in standard IEC 60870-5-103
LAN	Local area network. Ethernet based network for computers and relays.
NTP	Network time protocol for LAN and WWW
P	Active power. Unit = [W]
PF	Power factor. The absolute value is equal to cosφ, but the sign '+' for inductive i.e. lagging current and '–' for capacitive i.e. leading current.
PT	See VT
pu	Per unit. Depending of the context the per unit refers to any nominal value. For example for overcurrent setting 1 pu = 1xI_{GN}.
Q	Reactive power. Unit = [var] acc. IEC
RMS	Root mean square

S	Apparent power. Unit = [VA]
SNTP	Simple Network Time Protocol for LAN and WWW
THD	Total harmonic distortion
U_a	Voltage input for U_{12} or U_{L1} depending of the voltage measurement mode
U_b	Voltage input for U_{23} or U_{L2} depending of the voltage measurement mode
U_c	Voltage input for U_{31} or U_0 depending of the voltage measurement mode
U_N	Nominal voltage. Rating of VT primary or secondary
UTC	Coordinated Universal Time (used to be called GMT = Greenwich Mean Time)
VT	Voltage transformer i.e. potential transformer PT
VT_{PRI}	Nominal primary value of voltage transformer
VT_{SEC}	Nominal secondary value of voltage transformer
WWW	World wide web ≈ internet

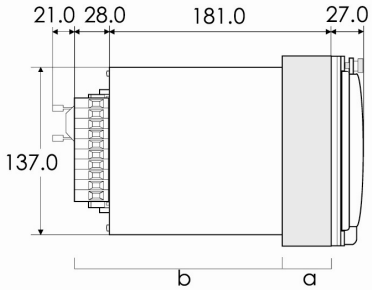
10. Construction

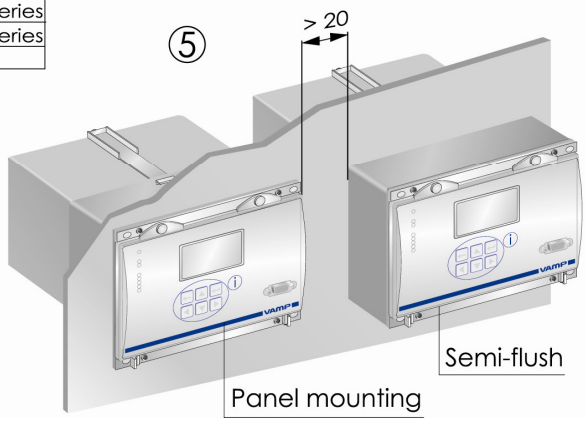
Panel mounting VAMP200 Series



Semi-flush VAMP200 Series

	a mm	b mm	Fixing bracket
VYX076	40	169	Standard for 200 series
VYX077	60	149	Standard for 200 series
VYX233	100	109	2 x VYX199

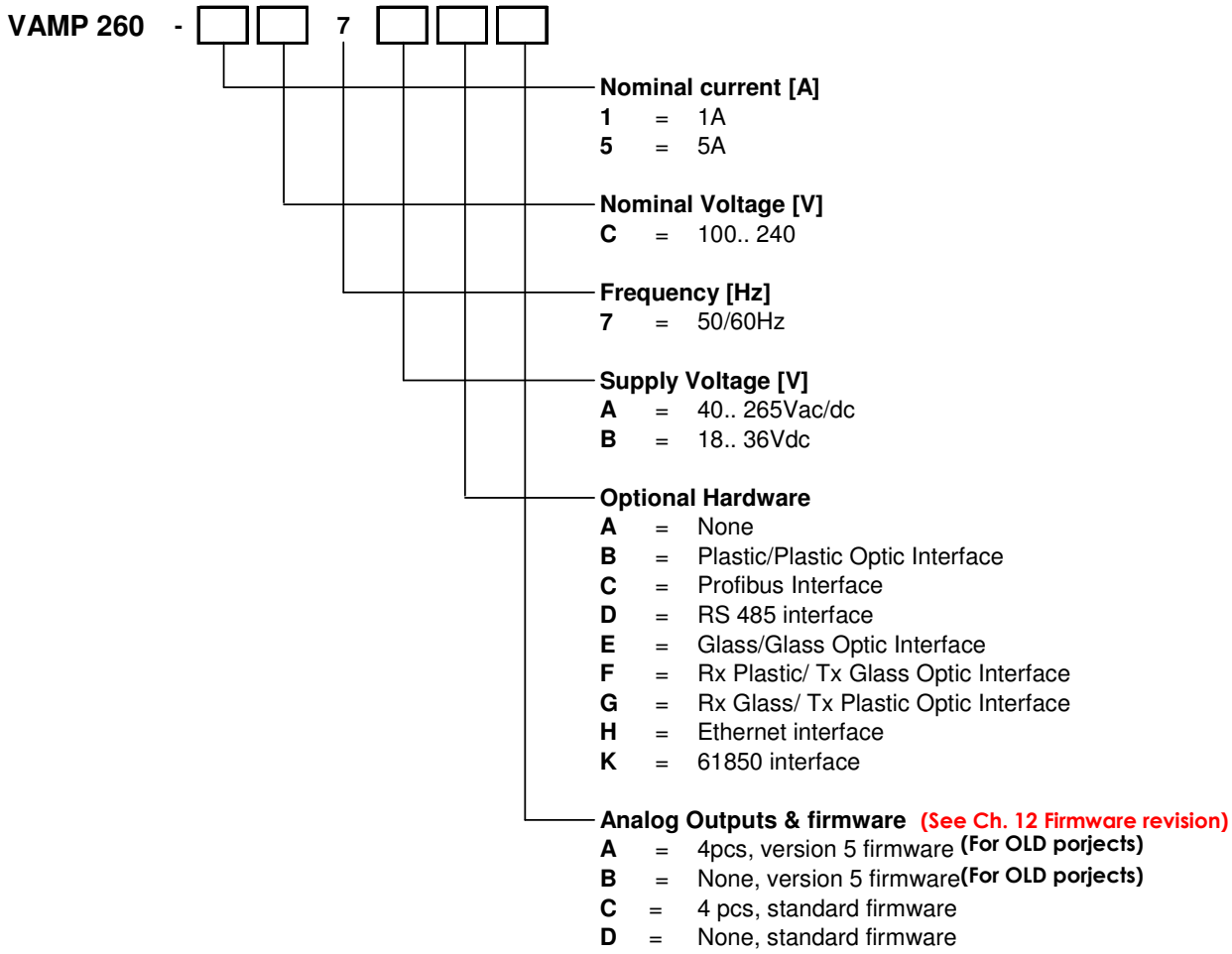




11. Order information

When ordering, please, state:

VAMP 260 ORDERING CODE


VAMP 260 - 7
Nominal current [A]
1 = 1A
5 = 5A
Nominal Voltage [V]
C = 100.. 240
Frequency [Hz]
7 = 50/60Hz
Supply Voltage [V]
A = 40.. 265Vac/dc
B = 18.. 36Vdc
Optional Hardware
A = None
B = Plastic/Plastic Optic Interface
C = Profibus Interface
D = RS 485 interface
E = Glass/Glass Optic Interface
F = Rx Plastic/ Tx Glass Optic Interface
G = Rx Glass/ Tx Plastic Optic Interface
H = Ethernet interface
K = 61850 interface
Analog Outputs & firmware (See Ch. 12 Firmware revision)
A = 4pcs, version 5 firmware (For OLD porjects)
B = None, version 5 firmware(For OLD porjects)
C = 4 pcs, standard firmware
D = None, standard firmware

Accessories :

Order Code	Explanation	Note
VEA 3 CG	External Ethernet Interface Module	VAMP Ltd
VPA 3 CG	Profibus Interface Module	VAMP Ltd
VSE001	Fiber optic Interface Module	VAMP Ltd
VSE002	RS485 Interface Module	VAMP Ltd
VX003-3	Programming Cable (VAMPSet, VEA 3 CG+200serie)	Cable length 3m
VX004-M3	TTL/RS232 Converter Cable (for PLC, VEA3CG+200serie)	Cable length 3m
VX007-F3	TTL/RS232 Converter Cable (for VPA 3 CG or VMA 3 CG)	Cable length 3m
VX015-3	TTL/RS232 Converter Cable (for 100serie+VEA3CG)	Cable length 3m
VX008-4	TTL/RS232 Converter Cable (for Modem MD42, ILPH, ..)	Cable length 4m
VYX076	Raising Frame for 200-serie	Height 40mm
VYX077	Raising Frame for 200-serie	Height 60mm
VM690/230	3 Phase Nominal Voltage Matching Transformer	690V->230V , 400V->110V

12. Revision history

12.1. Manual revision history

VM260.EN001	Changed device name from VMAC 260 VAMP 260. Changed company name from Vaasa Electronics to VAMP Ltd. Added disturbance recorder.
VM260.EN002	Editorial changes.
VM260.EN003	Updated the list of screens in "Function menu table.
VM260.EN004	Operating temperature has changed.
VM260.EN005	Many updates. Changed for SW ver 6.1
VM260.EN006	Direction of power and current added. More detailed notes in Order information.
VM260.EN007	"IEC 60870-5-101" added. "IEC 61850" added. "External I/O extension modules" added. Voltage measuring range changed from 0-260 V. Adjustments in technical data.

12.2. Firmware revision history

5.20 Name changed from VMAC 260 to VAMP 260.

5.31. Disturbance recorder added.

5.35 Clock synchronization added.

5.41 Support for VEA3CG TCP/IP-adapter added.

5.51 User timers added.

5.58 Block matrix added.

5.72 RMS calculations added.

5.74 Logic functions added.

6.23 A major update. Older versions of VAMPSET parameter files are not compatible and must NOT be used!

- Temperature measurement and supervising using external Modbus modules.
- Digital I/O extension using external Modbus modules.
- User's programmable logic
- User configurable interactive mimic display

- Language support (Latin alphabet)
- IEC 60870-5-103, DNP 3.0 and CLIR communication protocols added
- Supported for internal Ethernet adaptor (See Communication interface “H” in Chapter Order information)

13. Reference information

Documentation:

Mounting and Commissioning Instructions VMMC.EN0xx
VAMPSET User's Manual VMV.EN0xx

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